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ABSTRACT

A study was conducted to clarify a number of issues related to Piaget's theory of invariant sequantiality in child cognitive development. Ss were 143 middle-class white children of bright, average and retarded psychometric abilities (measured by performance on the Stanford-Binet Intelligence Test). Bright and average Ss were chronologically aged 5-7 years; retarded Ss were mentally aged 5-7 years and chronologically aged 6-12 years. Tests were individually administered in four sessions totalling about three hours as follows: guessing game, conservation of mass, family egocentrism, egocentrism in left-right perspective, constancy of generic identity, class inclusion, conservation of number, constancy of sex role, conservation of substance in the ring segment illusion, realism and internal-external differentiation in development of the dream concepts, conservation of length, transitivity of length, conservation of liquid continuous quantity, magic interview, object sorting, and the Holtzman Inkblot Test. Procedures, scoring, and results are given for each test. (KM)

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EVALUATION OF COGNITIVE DEVELOPMENT WITH PIAGET-TYPE TESTS: STUDY OF YOUNG BRIGHT, AVERAGE, AND RETARDED CHILDREN

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Final Report to the Department of Program Development for Gifted Children, Illinois Office of Public Instruction

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INTRODUCTION

Recent research with children (Kohlberg and DeVries, 1969), showing that psychometric measures of cognitive development tap a different aspect of intellect than do tasks developed by Piaget, led to a need to examine further the qualitative cognitive changes reflected by Piaget-type tasks, their unique utility in evaluating individual cognitive development, and their implications for educational practice.

The study reported here is concerned with clarifying a number of issues related to Piaget's theory of invariant sequentiality in child cognitive development. The focus is upon the period (from about five to seven years of age) in which Piaget finds an important qualitative change occurring in the structure and function of thought. The study goals are:

1. To refine Piaget's description of sequential change for fifteen tasks;

2. To investigate the relationship between cognitive development reflected by the Piaget tasks and that reflected by standardized tests of intelligence and achievement;

3. To explore the relative effects of chronological age, mental age, IQ, and sex upon progress toward concrete operational thought;

4. To examine the possible role of cognitive conflict as a factor in instigating progressive change in qualitative aspects of thought;

5. To pursue the question of decalage in development within a stage;

6. To investigate the relationship between cognitive development reflected by Piaget-type tasks and maturity level of responses to a projective (inkblot) test;

7. To consider the efficacy of some artifactual explanations accounting for immature performance in Piaget-type tasks;

8. To investigate several issues pertaining to details of Piaget's theory.

Pertinent Background Information

Jean Piaget's (Piaget, 1954; 1969; reviewed by Flavell, 1963, and Almy, 1966) extensive research led him to postulate that children progress through an invariant succession of four stages in their cognitive development, each stage being a new and different level of integration which incorporates the preceding stage; each of these stages, with the exception of the final stage of formal reasoning, possesses certain structural characteristics which lead to deficiencies in reasoning ability. In the study described here, the concern is with the period of transition from the second stage of preoperational thought to the beginning of the third

stage of concrete operational thought. This transition involves a lessening of the egocentric orientation which is expressed by the preoperational child's inability to overcome his subjective view and take other perspectives besides his own; his failure to make the subjective-objective differentiation results in a belief in the subjective as objective. The transition also involves an increasing mobility in thought; the peroperational child is capable only of thinking in terms of static states whereas the concrete operational child is capable of thinking in terms of dynamic transformations which are reversible. These deficits of the preoperational child result in the following failures which are overcome when the stage of concrete operations is achieved:

1. He cannot conserve, i.e., mentally maintain the invariance of an object or idea when transformations in irrelevant attributes occur. For example, the preoperational child believes the quantity of liquid to change with change in level when it is poured into a container with different dimensions.

2. He is unable to make a transitive inference. Piaget hypothesized this logical operation to be organized in a synchronized fashion with conservation. Transitivity is expressed in the statement that if A is greater than B, and B is greater than C, then A is greater than C.

3. He is unable to think in terms of a hierarchical classification system; if he is asked to compare one of two subclasses, for example, with the whole of which it is a part, he compares, instead, the two subclasses. For example, when presented with four M&M's and a mint, and told he should choose whichever has more to eat, either all the chocolate or all the candy, he selects the M&M's "because the mint is only one," even though he succeeds in giving the experimenter all five pieces when asked to "put all the candy in my hand." The preoperational child may use the verbal labels which suggest the possession of hierarchically organized thought, e.g., boy, girl, man, woman, but object sorting activities where he makes groupings on the basis of relations of liking, identical similarity, family membership, etc., suggest that no hierarchically arranged cognitive system is guiding his grouping.

4. He is unable to understand the relational meaning of left and right or the reciprocal nature of family relationships. Left and right are always thought of in relation to himself so that he believes that what is to his left is also to everyone else's left. Similarly, while he may say he has a brother, the fact that his brother has him for a brother is not grasped.

5. He does not believe that dreams are internal events caused by himself, but believes that they originate and occur externally.

6. Just as he accepts the possibility of change in quantity with change in appearance, he also accepts as real a "magical" transformation. For example, a toy cat transformed into a bird by means of a magician's change bag is believed to have disappeared. Even belief in magic is some progress from static acceptance of the change as a natural event.

7. As a result of his inability to take any perspective other than his own, he is unable to be deceptive and competitive, e.g., in a social

guessing game.

8. As a result of the static nature of his thought, he projects static rather than active percepts in response to the ambiguous stimuli of inkblots.

Piaget's view of intellectual development provides the focus for assessment of the intellect which is quite different from the psychometric method currently in use. The psychometric method is based on the notion that intelligence is unchanging. While it certainly is useful to know how a particular child compares with other children his age on a psychometric test (this information being expressed in terms of mental age and intelligence quotient), this knowledge does not tell anything about the structural nature of the child's intellect which, according to Piaget's theory, does change. Kohlberg (1963) discusses the distinctions between psychometric intelligence and developmental level, pointing out that tests of developmental level attempt to assess global thought process or structure, whereas psychometric tests are designed to assess thought product. The increasing amount of evidence (Hunt, 1961) indicating that IQ is not fixed and that intellectual competence can be greatly enhanced by experience or retarded by experiential deprivation has resulted in an increase in need for assessment techniques to supplement psychometric methods in the analysis of the cognitive capacities and needs of the individual. Hunt discusses the advantages which assessment of intelligence by Piagetian methods can have over the conventional methods, also pointing out that Piaget's description of the successive stages of intellectual development removes the necessity for some of the trial-and-error in determining an appropriate match between environmental circumstances (such as school experiences) and the nature of the central processes already developed in order to promote further growth of these processes that underlie intelligence.

In order to explore the possibility that Piaget-type tasks and psychometric tasks might actually be measuring the same aspects of intellect, a factor-analytic study (Kohlberg and DeVries, 1969) was undertaken in which a battery of tests of primary mental abilities and a battery of Piaget-type tasks were administered to 67 bright and average children five and six years of age. Since a first factor included all the tests of primary mental ability, and second and third factors included the Piaget tasks, it appears that the two assessment techniques do measure different aspects of cognitive function. Therefore, it seems to be important to focus upon the goals mentioned in the foregoing section of this proposal, further elaborated below:

1. Since Piaget's description of acquisition sequence is rather gross, a more detailed description of developmental changes occurring is sought which would provide a basis for operationalizing educational objectives.

2. In order to further explore the relationship between cognitive development reflected by Piaget tasks and that reflected by standardized tests already in widespread use, assessment of cognitive growth as measured by standardized achievement tests is compared with Piagetian measurement to find whether they, too, may measure different aspects of cognitive function.

3. General psychometric ability is controlled (bright, average, and retarded subjects are selected on the basis of IQ on the Stanford-Binet Intelligence Test) in order to assess the effect of mental age apart from IQ (retarded subjects are of mental age 5, 6, and 7 years and can be compared with the average subjects with the same mental age and with younger bright subjects with the same mental age). The effect of experience as indexed by chronological age is assessed by considering performance of subjects at different age levels within bright, average, and retarded groups. The possible effect of general ability (IQ) upon sequentiality in acquisition of prerequisites to Piaget's concrete operational cognitive skills is explored by assessing the order of acquisition separately for bright, average, and retarded subjects. The effect of sex upon cognitive development is considered because a number of studies (reviewed in Flavell, 1963) have shown differences with Piaget-type measures, usually in the direction favoring boys. Since psychometric test items are selected which do not differentiate on the basis of sex, this possibility particularly needs exploration.

4. Piaget (1962) discussed the relationship between affect and cognition, arguing that a specific affective reaction results from a discrimination, which is a cognitive act. Smedslund's (1961, 1964) study of conservation and transitivity has shown that it is important that children experience contradictions in order to develop an equilibrated cognitive system and has demonstrated that change is initiated by dissonant experiences. Relevant to this is the work of Charlesworth (1964) who showed that surprise and other involuntary emotional responses can be used as indicators of cognitive level in conservation of substance. He also presents convincing evidence that some deviation from what is expected improves the capacity for retaining information. The author's (1969) research on constancy of generic identity also provides evidence for the utility of affective assessment in the evaluation of the cognitive state; in that study rated discomfort, fear, and surprise were related to belief or disbelief in the transformation of a live cat into a ferocious-looking dog or benign-looking rabbit by means of realistic masks.

Conflict, rated from videotape and validated by comparison with timed response latencies, will be considered in relation to developmental level in order to investigate further the notion that the experience of dissonance may be important in transition from one stage to the next.

5. Piaget (1969) has noted time lags in development within stages where the child is able to solve problems in one situation or with one material but not in another situation or with other material. While he feels that the exact details of such a decalage are unpredictable and will vary inconsistently, it seems important to explore the extent to which there may be some consistency for these tasks and subjects. Though Piaget has found that conservation of mass, for example, precedes that of weight which, in turn, precedes conservation of volume, it would be useful if we could ascertain where other tasks generally fall, at least, in the sequence of development. To that end, the fifteen tasks employed in this study will be subjected to Bentler's (1969) monotonicity analysis.

6. Rorschach (1942) related the production of inkblot associations which involved movement to intelligence as well as to emotional processes. Beck's (1960) research resulted in the finding that children below the age

of seven rarely give movement responses, and this is substantiated by normative work by Ames (1952) and her colleagues, by Ford (1946), Ledwith (1959), Meyer and Thompson (1952), and Stein (1956). Gair (1947) found a higher frequency of movement responses in a group of very superior seven-year-olds.

The ability to produce a movement response to an inkblot seems to imply a kind of mental activity similar to what Piaget speaks about when he talks about reversibility. Both require a mental flexibility which makes possible the imagination of some displacement. However, it seems that movement percepts could arise from a cognitive structure capable only of renversibility (one-way reversing, rather than totally reciprocal reversing); therefore, movement percepts probably occur prior to conservation.

In addition to some possibly important implications for bridging the gap between psychoanalytic and cognitive views of child development, it seems that some advantage might obtain if the inkblot test can be shown to have some specific place in the diagnosis of cognitive development -- that of indicating development past the stage of static structure.

Recent work by Joe Thorpe (196), one of Holtzman's students, has yielded developmental indices which are derived from patterns of scores on the standard Holtzman scores. These are to be used in comparison with the developmental Piaget task scores.

7. The efficacy of some artifactual explanations for immature performance on Piaget tasks is investigated:

a. Memory of previous states or relationships is assessed to determine whether forgetting is a factor in preoperational functioning on concrete operational tasks in order to meet the frequent contention that nonconservers, for example, have simply forgotten the previous state of things.

b. The possibility that some children may respond with a set toward or against the object manipulated by the experimenter is controlled by sometimes manipulating the correct object and sometimes the incorrect one. This also controls for false-positives as a result of perseveration.

c. Some critics of Piaget's method have contended that immature responses are the result of requisite verbal facility. To counter this objection, tasks are designed, wherever possible, so that the child is asked to respond by pointing.

d. Other skeptics have argued that Piaget's subjects who appear so immature are simply not motivated to be correct or that they are simply responding as they think the experimenter wants them to. To deal with this objection, tasks were designed, wherever possible, in such a way as to capitalize on children's desire for such appealing edibles as colored gum sticks, candy, cookies, and Coco-Cola. Perceptual contradictions were arranged so that the smaller quantity appeared to be greater; thus, an immature child actually was taking the smaller quantity, though he strongly vowed he had gotten the bigger one.

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e. Some have argued that what appear to be immature responses to conservation tasks are the result of semantic confusion; they feel that failure to understand the terms "same," "less," and "more" cause artifactual nonconservation. In an effort to explore this possibility, unequal stimuli have been used throughout the conservation tasks. Verbal instructions have been simplified so that only an understanding of "more," the easiest of the comparatives previously mentioned according to a study by Griffiths, Shantz, and Sigel (1967), is required. In addition, the child was required to demonstrate his initial understanding of which object has "more to eat" before the change in configuration.

f. Bruner (1966) has contended that many young children possess the capacity to conserve but are misled by the perceptual contradiction into giving nonconservation responses. Since it appears to this investigator that the ability to respond in a conserving fashion when the perceptual contradiction is not present is better interpreted as an expectancy of constancy, and since conservation is not really tested without the apparent contradiction, prediction questions were included in the conservation tasks which provide a basis for further exploration of this issue.

8. Several issues pertaining to theoretical details are investigated:

a. Piaget has postulated that the logical operations of multiplication of relations and compensation are necessary to conservation of continuous quantity. This is explored by asking subjects to predict the level to which liquid will rise when poured into an opaque container from another differing in size.

b. Elkind (1967) has opened a controversy concerning the existence of two kinds of conservation -- conservation of the identity of a single quantity, and conservation of the equivalence relationship between the two quantities when one is altered and one is not. Elkind contends that conservation problems are equivalence situations but that interpretations are made in terms of identity; he suggests that identity conservation probably occurs prior to equivalence conservation. The use of unequal stimuli, use of equivalence conservation. The use of unequal stimuli, use of probes concerning whether the quantity "really gets to be more to eat/drink," and use of two identity tasks (generic identity and sex-role identity) will be explored at length in terms of this issue.

c. Questions of invariance in sequentiality and decalage have already been discussed as primary goals of the study.

DESCRIPTION OF STUDY

Subjects

Ss were 143 middle-class white children, of bright, average, and retarded psychometric abilities (measured by performance on the Stanford-Binet Intelligence Test) enrolled in the public schools of Champaign, Illinois. Bright and average children were chronologically aged 5-7 years; retarded Ss (including some pupils in Urbana and Saint Joseph, Illinois) were mentally aged 5-7 years and chronologically aged 6-12 years. Table A shows the distribution and characteristics of the sample.

Procedure

The battery of tests were individually administered in four sessions totalling about three hours, as follows:

Session 1:
- Guessing Game
- Conservation of Mass
- Family Egocentrism
- Egocentrism in Left-Right Perspective
- Constancy of Generic Identity
- Class Inclusion

Session 2:
- Conservation of Number
- Constancy of Sex Role
- Conservation of Substance in the Ring Segment Illusion
- Realism and Internal-External Differentiation in Development of the Dream Concepts
- Conservation of Length

Session 3:
- Transitivity of Length
- Conservation of Liquid Continuous Quantity
- Magic Interview
- Object Sorting

Session 4:
- Holtzman Inkblot Test

Videotapes were made of the magic interview and the five conservation tasks, and painstaking, time-consuming rating of conflict in choice situations and timing of all response latencies were made.

Testing was done in a 16-foot trailer especially built for this study which the experimenter moved to 16 schools in Champaign, Illinois (and to

TABLE A

MEAN CHRONOLOGICAL AGE, MENTAL AGE, AND IQ OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS IN STUDY 11 (N=143)

Age Group	Characteristics	Bright			Average			Retarded[a]		
		Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	N	8	8	16	9	8	17	8	5	13
	CA[b]	5-5	5-8	5-7	5-6	5-6	5-6	7-10	7-4	7-8
	MA[b]	6-10	7-5	7-2	5-10	5-9	5-9	5-6	5-3	5-5
	IQ	130	133	132	108	105	106	69	67	68
6	N	8	8	16	8	9	17	8	8	16
	CA[b]	6-6	6-6	6-6	6-7	6-5	6-6	8-6	8-9	8-7
	MA[b]	8-2	8-2	8-2	6-10	6-11	6-10	6-4	6-5	6-5
	IQ	129	129	129	104	107	105	74	72	73
7	N	8	8	16	8	8	16	8	8	16
	CA[b]	7-7	7-7	7-7	7-9	7-7	7-8	9-11	10-1	10-0
	MA[b]	9-8	9-9	9-9	7-11	7-11	7-11	7-5	7-6	7-6
	IQ	130	130	130	101	105	103	75	74	75
Mean All Ages	N	24	24	48	25	25	50	24	21	45
	CA[b]	6-6	6-7	6-7	6-7	6-6	6-6	8-9	8-11	8-10
	MA[b]	8-3	8-5	8-4	6-10	6-10	6-10	6-5	6-7	6-6
	IQ	130	131	130	104	105	105	72	72	72

[a]Age group classification for this group is mental age, rather than chronological age.

[b]Years and months.

a few schools in Urbana, and Saint Joseph, Illinois).

In addition to these measures, achievement test performance for bright and average Ss was obtained from the school system, and scores were interpolated for the time of Piaget testing.

LEFT-RIGHT PERSPECTIVE

METHOD

Procedure

The procedure employed is similar to that used by Piaget (1928), the major differences being that edible materials (Dentyne gum, animal cookies, and chocolate kisses) were utilized, and that two additional problems were presented to the child. The interview was conducted as follows.

Test items 1 and 2 were designed to find whether the S knew which objects in an array were to his left and right. The arrangement was in the following order, from child's left to right: gum, cooky, candy. E said:

1. I'm going to let you pick one of these in a minute, and if you pick the one I say, you can have it to keep or to eat. If you don't pick the one I say, you won't get a treat this time; you'll get another chance later. Now point to the one on your right.

If the S correctly selected the candy, he was allowed to take it and put it in his paper sack to take home. If he selected incorrectly, E corrected him, saying, "No, this one is on the right (pointing to candy). Let's try another one." The child was not allowed to take an incorrect choice. E then presented another array, in order, from the child's left to right: cooky, candy, gum. E said:

2. This time we'll put them like this. If you can pick the one I say this time, you can have it to keep or eat. If you don't pick the one I say, you won't get a treat this time; you'll get another chance later. Now, point to the one on your left.

If the child selected incorrectly, he was allowed to take his choice and the test was terminated inasmuch as such a child possessed insufficient knowledge of his own left and right to permit any valid conclusions concerning his knowledge of right-left from other perspectives.

Item 3 was designed to discover whether the child understood the

relativity of his own left-right relation to objects. If the child correctly selected the cooky, E said:

3. Yes, now that (cooky) is yours, but before you put it in your sack, we'll trade chairs for a minute. Come sit in my chair.

The child takes E's chair which is on the opposite side of the table from S's original seat; this results in left-right relationships which are reversed from those originally confronted. E said, "Now show me the one on your left." From this point on in the interview, the S was allowed to take the item he selected.[1] The child correctly selecting takes gum and cooky; the child incorrectly selecting takes whatever he chose.

Items 4 and 5 were designed to discover whether the child understood the left-right relativity of objects in relation to each other. E said, "Now you can come back to your seat." The new array presented from the child's left to right was: cooky, candy, cooky, gum. E said:

4. If you can pick the one I say this time, you can have it to keep or eat. If you don't pick the one I say, you won't get a treat this time; you'll have another chance later. Point to the one to the left of the gum.

S was allowed to take his choice, whether or not he correctly selected the cooky next to the gum. A new array was shown to the child, from his left to right: cooky, gum, candy, gum. E asked:

5. Now, point to the one to the right of the cooky.

Items 6 and 7 aimed toward discovering the S's ability to understand the left right relativity of objects in relation to another person. The array presented, from the S's left to right was: gum, cooky, candy. E said:

6. Now you give me a choice. Tell me which one to pick.

E responded to the instruction of S by selecting the object correct from E's perspective, and then asked, "Is that the one you said? Did I pick the one you said? If I pick the one on my left, which one should I take? How do you know?" A new array presented from child's left to right was: cooky,

candy, gum. E asked:

7. If I pick the one to my right of the candy, which one should I take? How do you know?

Items 8-11 were designed to assess the child's understanding of the relativity of left-right for another person.

8. (E faced child, holding doll in right hand.) Have I got the doll in my right hand or in my left hand?

9. (E held doll in left hand.) Have I got the doll in my left hand or my right hand? How do you know?

10. (E turned back to child, holding doll in right hand.) Have I got the doll in my right hand or in my left hand?

11. (E held doll in left hand.) Have I got the doll in my left hand or my right hand? How do you know?

Items 12 and 13 were for the purpose of verifying that the S did know his left and right hands.

12. Show me your right hand.

13. Show me your left hand.

Scoring

Subjects were scored as passing (+) or failing (-) each of the following items:

1. Knows own right-left hands

   +: Correct on Q10-11.

2. Views right-left as non-random variables

   +: Non-random patterns
   a. Correct on both Q1-2 and 10-11
   b. Incorrect on all questions (indicates consistency in perspective, though basic assumption of left/right is reversed)
   c. Incorrect on Q1, but correct on Q10-11, and consistency in other responses indicates that learning after correction did occur.

   -: Random patterns
   a. Incorrect on both Q1-2 and 10-11, with some, but not all, other responses correct
   b. Correct on Q1-2, but incorrect on Q10-11

c. Incorrect on Q1-2, correct on Q'0-11, with inconsistency in other responses such that learning after correction is suspect

3. Not always egocentric in views of left-right

+: a. If non-random view prevails, correct on Q6-7, or Q8-9, or Q4-5
b. Consistent in naming other's hands, i.e., one is identified as left whether E has back toward or faces S, and other is identified as right in both positions

Note: Subjects with random patterns are scored "-"

4. Views left-right in non-absolute fashion, i.e., knows that left-right change relative to his own perspective

+: If non-random, correct on Q3

Note: Subjects with random patterns are scored "-"

5. Applies other-opposite rule

+: Knows left right of other are opposite to own left-right when other faces him
a. If non-random and correct on Q1-2 and 10-11, correct on Q8-9
b. If non-random and incorrect on Q1-2 and 10-11, incorrect on Q8-9

6. Takes relative view of other's right-left hands

+: a. If non-random and correct on Q10-11, correct on Q8-9 and 12-13
b. If non-random and incorrect on Q10-11, incorrect on Q8-9 and 12-13

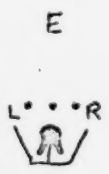
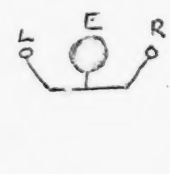
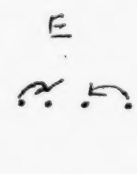
7. Takes relative view of object

+: If non-random, correct on both Q4-5 and Q6-7

In addition, invidividual patterns of responses to questions concerning left and right were analyzed in terms of 1) consistency in identifying own left and right, 2) understanding of the non-random nature of left and right, and 3) degree of relativity ascribed to the left-right concept. Table 1 shows patterns of responses given by Ss to test questions. (Not all possible combinations of responses occurred.) The left (L) and right (R) notations refer to what was designated left and right on all questions from the point of view of the reader as if he faced E on Q1-2. Whether the

TABLE 1

Categories of Response[a] Patterns in Test of Left-Right Perspective

Response Pattern Category (View of Left and Right)		Q1-2	Q3	Q10-11	Q6-7	Q8-9	Q12-13[b]	Q4-5	Pattern Frequency
		 C	E	C	C	C	 C	 C	
1. Variable	a.	RL-	L+	RL-	LR-	RL+	0	-	3
	b.	RL-	L+	RL-	LR-	LR-	0	-	1
	c.	RL-	R-	RL-	LR-	RL+	0	-	3
	d.	RL-	L+	RL-	LR-	RL+	0	+	2
	e.	LR+	L+	RL-	LR-	LR-	0	+	1
	f.	LR+	L+	RL-	RL+	RL+	0	+	1
	g.	LR+	L+	RL-	LR-	RL+	0, RL-	-	5
	h.	LR+	L+	RL-	LR-	RL+	0, RL-	+	3
	i.	LR+	R-	RL-	LR-	RL+	0	-	1
	j.	LR+	R-	RL-	LR-	RL+	0	-	1
	k.	LR+	R-	RL-	RL+	RL+	0	+	3
	l.	LR+	L+	RL-	LR-	LR-	RL-	-	1
	m.	LR+	R-	RL-	RL+	LR-	LR+	-	1
	n.	RL-	R-	LR+	LR-	RL+	0	+	2
	o.	RL-	R-	LR+	LR-	RL+	LR+	-	1
	p.	RL-	R-	LR+	LR-	RL+	0, RL-	-	5
	q.	RL-	R-	RL-	LR-	LR-	0, -	-	3
	r.	RL-	L+	LR+	RL+	LR-	0	-	1
									38
2. Egocentric and Absolute	a.	LR+	R-	LR+	LR-	LR-	0, RL-	-	16
	b.	LR+	R-	LR+	LR-	LR-	0	+	7
	c.	RL-	R-	LR+	LR-	LR-	0	+	1
	d.	RL-	R-	LR+	RL+?	LR-	0	-	1
									25

[a]Left (L) and right (R) designations refer to what was designated left and right from the point of view of one facing E on Q1-2. Pass (+) and fail (-) designations indicate whether the response is objectively correct.

[b]Patterns with a "0" for Q12-13 are those where this question was not asked.

TABLE 1 (CONTINUED)

Response Pattern Category (View of Left and Right)		Q1-2	Q3	Q10-11	Q6-7	Q8-9	Q12-13[b]	Q4-5	Pattern Frequency
3. Egocentric, but not absolute	a.	LR+	L+	LR+	LR-	LR-	LR+	-	5
	b.	LR+	L+	LR+	LR-	LR-	LR+	+	8
	c.	RL-	L+	LR+	LR-	LR-	RL-	-	5
	d.	LR+	L+	LR+	RL+	LR-	0	-	1
	e.	RL-	L+	LR+	LR-	0, LR-	RL-	+	4
	f.	LR+	L+	LR+	LR-	LR-	RL-	-	1
									24
4. Opposite for other person	a.	LR+	L+	LR+	LR-	RL+	RL-	+	2
	b.	LR+	L+	LR+	RL+	RL+	RL-	-	2
	c.	LR+	L+	LR+	RL+	RL+	RL-	+	1
	d.	LR+	R-	LR+	LR-	RL+	0	-	1
	e.	LR+	R-	LR+	LR-	RL+	0	+	5
	f.	LR+	L+	RL-	LR-	LR-	RL-	-	1
									12
5. Relative for other, but not for object	a.	LR+	L+	LR+	LR-	RL+	LR+	+	16
	b.	LR+	L+	LR+	LR-	RL+	0	-	1
	c.	LR+	L+	LR+	RL+	RL+	LR+	-	5
	d.	LR+	R-	LR+	RL+	RL+	LR+	-	2
	e.	RL-	L+	LR+	LR-	RL+	LR+	-	2
	f.	RL-	L+	LR+	LR-	RL+	LR+	+	1
	g.	RL-	L+	LR+	RL+	RL+	LR+	-	1
	h.	RL-	R-	RL-	LR-	LR-	RL-	-	2
									30
6. Totally relative	a.	LR+	L+	LR+	RL+	RL+	LR+	+	13
	b.	RL-	L+	LR+	RL+	RL+	LR+	+	1
									14

designation is objectively correct is indicated by + (correct) or - (incorrect). The entire pattern of test responses is then studied to ascertain an individuals's view of left and right. Patterns are classified into six categories:

1. Variable: Patterns indicating that left and right are viewed as random variables are of three types. In Patterns a-d the S incorrectly identifies his own right and left hands (Q10-11) as well as objects to his left and right (Q1-2), but he does not consistently give the objectively incorrect responses to other questions; thus, his left-right perspective cannot be accounted for in terms of a simple reversal. In Pattern a, for example, the S gives the objectively correct responses when asked to take E's seat and show the object on his left (Q3) and when asked to identify E's hands (Q8-9); however, these "correct" responses in the context of incorrect identification of the S's own left and right (Q1-2 and Q10-11) are abrogated. One might suggest that since the object correctly designated "left" on Q3 was the one incorrectly designated "left" on Q2, the S may possess the absolutist view that once an object is given a name, the name remains. However, this interpretation is contradicted by the inconsistency in left-right designations on Q6-7 and Q8-9.

Therefore, it appears that the S showing this pattern of responses does not think of left and right as an orderly concept, but, rather, has only a vague and variable notion of left and right as names or positions.

The remaining Variable patterns were similarly analyzed. The second type (Patterns e-m) are those where Ss correctly identified objects to their own left and right hands (Q10-11), with other responses showing inconsistency in the view of left and right. The third type (Patterns n-r) include those where Ss failed to correctly identify objects to their left and right (Q1-2), did correctly identify their left and right hands by the

end of the test (10-11) but showed inconsistency in their view of left and right on other questions.

2. Egocentric and absolute: The egocentricity of the patterns in this category is expressed by the consistent designation of left and right in terms of the S's own left and right. The absolute character of these patterns is reflected by the belief that once an object is named "left" (Q3), it retains the name, even when the S's relationship to the object is reversed. Pattern b is included in this category, in spite of objectively "correct" responses to Q4-5, since it is possible to obtain correct responses by interpreting "...to the left/right of the gum/cooky" as "beside the gum/cooky." Pattern c is parallel to Pattern b except for initial reversal of left and right; correction resulted in subsequent consistency in perspective. Pattern d (one case) also shows profit from correction with such questionable success on Q6-7 that overall performance appeared to justify classification in this category.

3. Egocentric, but not absolute: Ss in this category are those showing the egocentric pattern described in Category 2 but who do show a grasp of the relativity of their own left-right perspective by succeeding on Q3. It should be noted that success on Q12-13 can reflect an active egocentrism since E's back is to S and both thus share the same left-right perspective; success on Q12-13 is a positive sign of correct left/right perspective only in the context of success on Q10-11. Types e and f (exhibited by only one S) are somewhat ambiguous inasmuch as labels for 's hands are retained when E turns her back to S (Q12-13). This may reflect that some vestige of the absolute view remains, or it could suggest a variable view. This pattern is especially difficult to interpret in light of the fact that the object to S's right was incorrectly labeled (Q1).

It appeared that correction resulted in S's "learning" the correct labels because of the consistency in egocentric responses thereafter, and it was concluded that Category 3 was the most reasonable placement since S possibly reverted to his original incorrect labeling of his own left and right.

4. Opposite for other person: Patterns in this category are characterized by the fact that they show some relativity but exhibit the application of an "other-opposite" rule with regard to the designation of E's hands. While S understands that the hand of a person facing him is given the label corresponding to his own hand on the opposite side, he also believes that the opposite label is applied when the other person turns his back and faces the same direction as the child. Type d exhibits an instance where S believes that his left is right and vice versa, but the pattern of responses shows the same belief in the other-opposite rule.

5. Relative for other, but not for object: Failure on at least one question pertaining to object perspective (Q6-7 and 4-5) characterizes patterns classified here. Types a-c are the clearest examples. Type d (exhibited by two Ss) seems to be most compatible with this category, despite the failure on Q3. Types e-g appear to have profited from their corrected failure on Q1 and show correct consistency in responses thereafter, except for the questions pertaining to objects. Type h is another instance of a pattern corresponding to the type of thinking characteristic of the category, but where responses are all based on inaccurate labeling of left and right.

6. Totally relative: Patterns in this category include those where the objectively correct responses were given to all questions, and those where only the first question was missed and Ss subsequently gave all correct responses.

RESULTS

Developmental Sequence

Several lines of evidence suggest that the set of items presented above can be accepted as a description of an invariant developmental sequence of acquisition:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis[2] using Green's (1956) summary statistics was performed which indicates that the seven dichotomous items form a Guttman scale (See Table 2 for reproducibilities and indices of consistency). Table 3 shows the eight perfect scale patterns possible and indicates the number of Ss in each ability group found for each scale type. Only four of the Ss scaled showed patterns which did not conform to one of the perfect types.[3]

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 4 indicates that younger children do not tend to score at the higher scale levels and that older children do not score at the lower levels. This is reflected in an increase in mean scale scores with increasing age for bright and average Ss, as shown in Table 5. Also, the median age of each scale type, even with the reduced number of subjects included in the scaling, generally increases as one proceeds from scale level 0 to 7 for average and bright groups (See Table 3). In addition, Table 6 provides even more definitive positive evidence, showing that the proportion of Ss passing each scale item increases with age.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 7 indicates that of 19 Ss retested after one year, 16 either performed at the same or higher levels, with only

TABLE 2

Scalogram Analysis[a] of Left-Right Perspective

Ratios Computed	Bright	Average	Retarded
Reproducibility	1.00000	.97960	1.00000
Chance Reproducibility	.81848	.82816	.84203
Index of Consistency	1.00000	.88128	1.00000

[a]Using Green's (1956) summary statistics

TABLE 3

Number of Bright, Average, and Retarded Subjects Scoring at Eight Levels on Scale of Development of Left-Right Perspective

(N=79)

ITEMS							
Scale Types	1	2	3	4	5	6	7
7	+	+	+	+	+	+	+
6	+	+	+	+	+	+	-
5	+	+	+	+	+	-	-
4	+	+	+	+	-	-	-
3	+	+	+	-	-	-	-
2	+	+	-	-	-	-	-
1	+	-	-	-	-	-	-
0	-	-	-	-	-	-	-
n	52	46	42	39	33	28	11
$\bar{n}$	27	33	37	40	46	51	68

BRIGHT			AVERAGE			RETARDED		
Scale Type	Non Scale Type	Med. Age-Sc. Ty.	Scale Type	Non Scale Type	Med. Age-Sc. Ty.	Scale Type	Non Scale Type	Med. Age-Sc. Ty.
7	0	94	2	0	94	2	0	121
5	0	88	7	0	94	3	0	110
2	0	82	2	2	93	1	0	125
3	0	68	1	0	92	2	0	105
0	0	-	2	1	63	0	0	-
2	0	70	1	1	67	0	0	-
1	0	69	3	0	72	4	0	106
7	0	68	6	0	68	12	0	111
27	0		24	4		24		

TABLE 4

Percentage of Bright, Average, and Retarded Children at Three Ages[a] Scoring at Eight Left-Right Perspective Scale Levels (N=140)

Ability Group	Age	Scale Items 0	1	2	3	4	5	6	7
Bright	5 (N=16)	43	07	12	12	12	07	07	00
	6 (N=16)	06	00	12	12	25	19	13	13
	7 (N=16)	00	00	00	06	12	13	31	38
Average	5 (N=17)	47	06	11	18	00	00	18	00
	6 (N=17)	06	17	24	24	00	00	18	11
	7 (N=16)	00	00	00	06	12	31	38	13
Retarded	5 (N=12)	25	09	25	08	09	16	08	00
	6 (N=16)	19	06	19	25	06	06	12	07
	7 (N=16)	31	12	00	06	13	13	19	06

[a]Bright and Average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 5

Mean Left-Right Perspective Scale Scores for Bright, Average, and Retarded Children at Three Ages[a] (N=143)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys (N=24)	Girls (N=24)	All (N=48)	Boys (N=25)	Girls (N=25)	All (N=50)	Boys (N=24)	Girls (N=21)	All (N=45)
5	0.50	3.25	1.88	2.33	1.12	2.76	3.00	0.80	2.15
6	5.00	3.37	4.18	3.62	2.88	3.23	3.38	2.50	2.94
7	5.62	6.00	5.81	6.00	4.75	5.37	3.25	2.50	2.88
Mean All Ages	3.83	4.21	3.96	3.96	2.92	3.79	3.21	2.10	2.98

[a]Bright and Average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 6

Percentage of Bright, Average, and Retarded Children Succeeding on each Left-Right Perspective Scale Item at three Ages[a] (N=143)

Ability Group	Age Group	Scale Items						
		1	2	3	4	5	6	7
Bright	5 (N=16)	62	56	38	25	12	00[e]	00
	6 (N=16)	94	94	75	62	44	57[c]	12
	7 (N=16)	100	100	94	94	81	89[d]	38
Average	5 (N=17)	56	44	31	19	19	14[h]	00
	6 (N=17)	82	82	47	41	29	00[b]	18
	7 (N=16)	94	100	94	88	81	75[f]	12
Retarded	5 (N=12)	83	53	41	17	25	29[c]	00
	6 (N=16)	75	75	44	50	25	29[c]	12
	7 (N=16)	62	50	50	46[i]	31	23[g]	06

[a] Bright and Average S s are grouped according to chronological age, and retarded S s are grouped according to mental age.

[b] N=3

[c] N=7

[d] N=9

[e] N=11

[f] N=12

[g] N=13

[h] N=14

[i] N=15

TABLE 7

Frequency and Direction of Change in Left-Right Perspective
Among Subjects Retested After One Year
(N=19)

Score at First Testing	Score at Second Testing							
	0	1	2	3	4	5	6	7
0			3	1	1		2	
1							1	
2	1		1		1	1	1	
3				1		1		
4			1					
5						1		
6							1	
7							1	

3 Ss scoring at a lower level the second year.

The foregoing findings combine to show that the sequence from easiest to most difficult on the scale is an age-wise progression which appears to occur in a regular, invariant order. However, the question of whether any steps in the sequence might be skipped cannot be answered until individual children are followed longitudinally.

Comparison of Response Pattern Scores and Guttman Scale Scores

The Guttman scale and the set of Response Patterns both describe the developmental sequence of acquisition of left-right perspective, but the Response Patterns represent a slight condensation. Scale Items 2 and 4-7 correspond to Response Patterns 2-6. Failure on all scale items results in a Variable Response Pattern 1. The scale included two items (1 and 3) which are not reflected directly in discrete Response Patterns. In addition to this source of discrepancy between scores, scale errors result in some lack of correspondence. Therefore, a Pattern Score of 3 does not necessarily predict a scale score of 4, as one might expect. The frequency distribution of Scale and Pattern Scores shown in Table 8 indicates that the correspondence is reassuringly close. While the Scale Score provides a somewhat more differentiated measure for the purpose of overall group comparisons, the Response Pattern Score seems to be a better descriptor of the qualitative level of thinking. Table 9 presents the percentage of Ss classified in the six Response Pattern categories, by age, sex, and ability. Table 10 summarizes these by age and ability group.

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis was performed separately for each ability group to ascertain whether the order of difficulty varies for different

TABLE 8

Frequency Distribution of Response Pattern Scores and Guttman Scale Scores
(N=143)

Response Pattern Score	Guttman Scale Score							
	0	1	2	3	4	5	6	7
1. Variable	28	11	-	-	-	-	-	-
2. Egocentric and Absolute	-	-	14	9	1	-	-	-
3. Egocentric, but not Absolute	-	-	1	9	14	-	-	-
4. Opposite for Other Person	-	-	-	-	-	12	-	-
5. Relative for Other, but not for Object	-	-	-	-	-	4	26	-
6. Totally Relative	-	-	-	-	-	-	-	14

TABLE 9

Percentage of Subjects in Three Ability Groups Taking Six Views of Left-Right Relationships, by Age[a], Sex, and Ability
(N=143)

	BRIGHT									AVERAGE									RETARDED								
	5's			6's			7's			5's			6's			7's			5's			6's			7's		
	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot	B	G	Tot
1. Variable	75	13	44	00	13	07	00	00	00	33	75	53	13	33	24	00	00	00	25	60	38	13	37	25	37	62	50
2. Egocentric and Absolute	13	37	25	13	25	19	00	00	00	44	13	29	25	33	29	00	00	00	25	40	31	25	25	25	00	00	00
3. Egocentric, not Absolute	12	25	19	25	37	31	25	13	19	00	00	00	25	12	18	00	37	19	13	00	08	37	13	25	25	00	13
4. Opposite for Other	00	13	06	12	25	19	13	12	13	00	00	00	00	00	00	00	37	19	12	00	08	13	00	06	13	00	06
5. Relative for Other	00	12	06	25	00	12	25	38	31	23	12	18	25	11	18	75	25	50	25	00	15	00	25	13	25	25	25
6. Totally Relative	00	00	00	25	00	12	37	37	37	00	00	00	12	11	11	25	00	12	00	00	00	12	00	06	00	13	06

TABLE 10

Percentage[a] of Bright, Average, and Retarded Children in Six Categories of Performance in Test of Left-Right Perspective, by Age[b] (N=143)

Response Pattern Category View of Left and Right:	BRIGHT				AVERAGE				RETARDED			
	5 (N=16)	6 (N=16)	7 (N=16)	Total (N=48)	5 (N=17)	6 (N=17)	7 (N=16)	Total (N=50)	5 (N=13)	6 (N=16)	7 (N=16)	Total (N=45)
1. Variable	44	07	00	17	53	24	00	26	38	25	50	39
2. Egocentric and Absolute	25	19	00	15	29	29	00	20	31	25	00	18
3. Egocentric but not Absolute	19	31	19	23	00	18	19	12	08	25	13	16
4. Opposite for Other Person	06	19	13	12	00	00	19	06	08	06	06	06
5. Relative for Other but not for Object	06	12	31	17	18	18	50	28	15	13	25	17
6. Totally Relative	00	12	37	16	00	11	12	08	00	06	06	04

[a] The Median for each age group is underlined.

[b] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

levels of intelligence and whether the same developmental sequence applies. The order of item difficulty is identical for bright, average, and retarded groups, and Table 2 indicates that the set of items is scalable for all three groups. The chronological progression along the scale of development is clear for bright and average groups, as indicated by mean scores in Table 5 and performance on individual scale items in Table 6. This progression does not apply to mental age, as the retarded group (which is not grouped by chronological age, but by mental age) does not generally show increases with increased mental age.

Level of Performance

While there are some interactions with sex which complicate the comparison of ability groups, bright Ss , particularly girls, show some tendency to perform at a somewhat higher level than average Ss (See Table 5). However, the analysis of variance comparing bright and average groups indicated that this difference is not statistically significant ($F=1.81$, $df=5$). The performance of average and retarded Ss at mental ages five and six years is comparable, but average Ss outdistance retarded Ss at mental age seven ($F=3.23$, $df=1, 86$, $p<.08$).

Consideration of performance reflected by Response Pattern Categories in Table 10 reveals essentially the same picture. About half the five-year-old Ss even those who are bright, view left and right as variable, and approximately one-quarter are egocentric and absolute in their view. At age five little difference between bright and average children appears; while somewhat fewer bright children (44 percent of bright and 53 percent of average) show the variable view, more average children (18 percent) view the left and right of another person as relative than do bright children (6 percent). Table 10 suggests, however, that bright children abandon the

variable view somewhat sooner than average children. Only 7 percent of bright but 24 percent of average Ss were classified as variable in their view at age six. Somewhat earlier development of left-right perspective among brighter children is also suggested by the finding that at age seven 37 percent of bright, but only 12 percent of average Ss showed a totally relative view. By age six, fewer bright than average Ss are categorized as variable in their view, and both groups show more children in more advanced categories. At age seven no bright or average child is found in the two most immature categories; all have given up the variable and absolute views. However, three times as many bright as average Ss have advanced to the totally relative view of Category 6. The slight advantage of bright over average children is also reflected by median categories at each age level. The median for bright Ss is one category higher at ages five and six. Retardates at mental age six are little different from average children of the same mental age, but by age seven many more average Ss are found in the advanced categories, and only two retarded Ss showed totally relative views.

Sex Differences

Tables 5 and 9 indicate that girls in general do more poorly with regard to left-right perspective than do boys. Exceptions are bright five-year-olds and bright seven-year-olds; at five, girls perform at a much higher level, and at seven, girls perform at a slightly higher or comparable level. At age five, 75 percent of the bright boys in this study showed a variable view of left and right (no boy in this group knew which object was on his right at the beginning of the task), while only 13 percent of the girls did so; girls in this group were even found showing Category 4 and 5 patterns, while no boy took a view higher than Category 3. At age six,

however, bright boys were found in Categories 5 and 6, while no girls showed these patterns. By age seven, all bright children were beyond Categories 1 and 2, and the two groups were quite comparable.

Average girls do more poorly at every age than do boys. At age five, only 33 percent of the boys, but 75 percent of the girls show a variable view. At age six, only 13 percent of the boys but 33 percent of the girls respond with this pattern. Average boys at seven are only found in Categories 5 and 6, whereas girls are concentrated in Categories 3-5.

Among the retarded Ss at every mental age level, girls are found at least twice as frequently as boys in the lowest category. At mental age five, 50 percent of the boys are found in Categories 3-5, while all the girls are concentrated in Categories 1 and 2. At age six, over 50 percent of the girls are still found in these categories, while over 60 percent of the boys are in higher categories.

CONSERVATION OF MASS

METHOD

The method of assessing ability to conserve mass parallels Piaget's study of this phenomenon, except that Piaget used clay, and the material used in this study is a pink fondant candy.[5]

Procedure

The S was seated at a child-sized desk on which a sheet of waxed paper was laid. The first task item was included in order to measure response latency in a situation likely to induce conflict over which of two balls has more to eat. E (wearing plastic gloves) placed two balls of fondant, each 2" in diameter, on a piece of waxed paper on a desk in front of the child. E kept balls covered with her hands while she said:

> I have two balls of candy here. If you can show me the one with more candy to eat, you can have it to keep or to eat. If you don't pick the one with more candy, you won't get any this time, but you'll get another chance later. Now, (removing hands) which one has more to eat?

When S pointed to the ball he judged correct, E placed a piece of plastic film directly in front of the child and between, but a bit below, the two balls, saying, "Take the one with more candy to eat. You can wrap it in this paper and put it in your sack to take home with you."

1. The first test item assessed conservation when a small ball was elongated. E placed two balls of candy, one about 3" in diameter, the other about 2" in diameter on the waxed paper, with the larger ball to S's left, saying:

> Look, here are two more balls of candy. Can you see that one has more to eat than the other? Which one has more? Yes, that has more to eat. I'm going to let you pick one in just a minute. But, first, watch. I make this one like this. If you can show me the one with more candy to eat, you can have it to keep or to eat. If you don't pick the one with more candy, you won't get any this time, but you'll get another chance later. (E talks as she rolls the candy into a sausage-shape about 4" long.) Now, look at both of them. Which has more to eat? How do you know that's more to eat? Which is bigger?

If a conservation choice (the larger ball) was made, the following limits-

testing procedure was followed:

> Now watch. I'm rolling the candy longer and longer (E rolls it out to about 6" in length.) Which has more to eat?
>
> Which had more to eat before I rolled this (pointing to smaller quantity) out? Did it really change? Did this really get to be more candy to eat?
>
> If no: Why not?
> If yes: How did that happen?

In order to provide one last opportunity for a child to select the greater quantity (in case a nonconservation choice was made for some reason other than actual belief in change), E placed a piece of plastic film in front of the child and said, "O.K., take the one with more to eat and put it in your sack." The child was allowed to take the candy he chose, whether he was objectively correct or incorrect.

2. The second test item assessed conservation when the small ball was flattened into a circular shape. E placed two balls of candy, one about 3" in diameter, the other about 2" in diameter, on the waxed paper, with the larger ball to S's right, saying:

> Here's some more candy. Which one has more to eat? Yes, that has more. Now watch. I make this candy like this. In just a minute, if you can show me the one with more candy to eat, you can have it to keep or eat. If you don't pick the one with more candy, you won't get candy this time. (E talks as she flattens the smaller ball into a circular shape about 4" in diameter, and the candy is partially hidden as she presses it.) Which has more to eat? How do you know that's more to eat? Which is bigger?
>
> Which had more to eat before I flattened this (pointing to pancake shape). Did this really get to be more candy to eat?
>
> If no: Why not?
> If yes: How does that happen?

3. The third test item was designed as a further limits-testing for conservers and also as a means of eliciting verbalized principles. E asked (only conservers):

> What could I do to make this (pointing to pancake) have more candy to eat than that one (pointing to larger ball)? Why or why not?

4. The final test item provided a last opportunity for an S to express his belief about the quantity. E placed a piece of plastic film in front of the child and said, "Now you take the one with more candy to eat. Why did you take that one?

Scoring

Ss were scored pass (+) or fail (-) on each of the following items:

1. Recognizes initially which ball has more to eat

   +: Points to larger ball of candy when asked to show which has more to eat

   Note: Subjects who cannot do this are not testable. If an error is made, E allows S to take his choice and provides another discrimination trial, pinching some off the smaller ball so the size discrepancy is greater. If S succeeds in selecting the larger, this item is scored "+" and testing proceeds; if S again selects the smaller, testing is terminated.

2. Remembers which ball had more before shape change

   +: Points to larger ball when asked to point to the one that had more before

3. Recognizes that the ball has greater quantity or is greater in some dimension after shape change.

   +: a. Says ball has more to eat
      b. Says ball is bigger, fatter, rounder, higher

4. Maintains constancy at some point

   +: At some time during the test, says ball has more to eat when smaller ball has been deformed.

5. Believes quantity didn't really change

   +: Says smaller ball did not really get to be more to eat; did not really change on all postulations of the question (asked twice only, except in special circumstances where response was unclear)

   Note: - is scored if S spontaneously verbalizes that the ball had more before, but the HD/PC has more after deformation.

6. Consistently conserves

   +: Takes larger ball on both Q2 and Q2, and also on Q1a if asked

7. Confidently conserves

+: Never even considers the possibility that the smaller may have more to eat when shape is changed; always says the ball has more

In addition, verbalized reasons for choices were scored as follows:

Nonconservation

1. No reason or irrelevant reason, e.g., "It's more/bigger," "You rolled/smashed it."
2. Quantity changed because E rolled/flattened the ball.
3. Magic
4. It looks bigger/longer/wider.

Conservation

5. No reason or irrelevant reason; description of what E did.
6. Shape/length irrelevant to quantity, e.g., "It just looks like it's bigger." "It doesn't change in size, just in shape."
7. Identity, e.g., "It was bigger before." "It's still little." "Because that was the little/big one at first."
8. Empirical reversibility, e.g., "If you put it back in a ball it would still be the same size." "If you rolled that ball (larger) out, too, it would be longer than that (sausage) one."
9. Compensation of relations, e.g., "It's flatter, but wider." It's longer but skinnier."
10. Addition-subtraction principle, e.g., "You can't make it bigger unless you add some more candy." "It can't change unless you break some off."
11. Generalization, e.g., "It stays the same, no matter what you do." "It wouldn't change; it's still smaller/bigger. It would still be the same."

Verbalizations were scored separately for test items 1 and 2, and S's giving multiple reasons were given multiple scores.

Results

A scalogram analysis using Green's (1956) summary statistics was

performed which indicated that the set of seven items presented above forms a Guttman scale. Table 11 shows the reproducibilities and indices of consistency for bright, average, and retarded groups, and indicates that the scale's order of difficulty is applicable to all IQ groups.

Developmental Sequentiality of Acquisition

Although the evidence is not as strong for this scale as for most others in this study, it does suggest that the Guttman Scale describes a developmental sequence of acquisition. Several lines of evidence converge to this tentative conclusion:

1. Age-wise progression along the scale: A general age increase appears from five to six years, but seven-year-olds perform at about the same level as six-year-olds. Since this is the case, and since no Ss are found at the two lowest scale levels, it appears that a broader age range of performance is necessary for a more definitive statement. Nevertheless, a general increase in median age as one proceeds up the scale levels can be seen in Table 12, especially for bright Ss. Mean scores in Table 13 show the increase in performance from five to six years, but no increase from six to seven years, and the age differences in performance are not significant (for bright and average Ss, $F=2.45, df=2,86, p<.09$; for average and retarded Ss, $F=1.80, df=2,83, p<.17$). Table 14 indicates that younger Ss tend to be found at somewhat lower scale levels than do older Ss. Tables 15 and 16 also show a clear age change from five to six years, but no progression from six to seven years with regard to the percentage of scale scores and percentage succeeding on each scale item in each age and IQ group. Thus, during the age range studied, change is occurring very slowly, particularly after age six.

2. Longitudinal progression: Table 17 presents the frequency distribution of scale scores at first testing and again one year later. Eight of the nineteen

TABLE 11

RESULTS OF SCALOGRAM ANALYSIS[a] OF MASS CONSERVATION ITEMS

Ratios Compared	Bright (N=48)	Average (N=49)	Retarded (N=45)
Reproducibility	1.00	.99	.99
Chance Reproducibility	.88	.90	.89
Index of Consistency	1.00	.94	.97

[a]Using Green's (1956) summary statistics

TABLE 12

MEDIAN AGE AND FREQUENCY OF SUBJECTS AT EACH CONSERVATION OF MASS SCALE LEVEL
N=142

Scale Type	Scale Items							Bright			Average			Retarded		
	1	2	3	4	5	6	7	Scale Type	Non Scale Type	Median Age of Scale Type	Scale Type	Non Scale Type	Median Age of Scale Type	Scale Type	Non Scale Type	Median Age of Scale Type
7	+	+	+	+	+	+	+	24	0	80	12	0	79	10	0	115
6	+	+	+	+	+	+	-	0	0	-	3	0	82	2	1	101
5	+	+	+	+	+	-	-	3	0	78	4	1	68	2	0	107
4	+	+	+	+	-	-	-	3	0	77	5	1	66	9	0	98
3	+	+	+	-	-	-	-	8	0	73	10	0	66	4	0	100
2	+	+	-	-	-	-	-	10	0	73	13	0	84	17	0	100
1	+	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
0	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
								48	0		47	2		44	1	
n	142	142	102	79	61	53	47									
$\overline{n}$	0	0	40	63	81	89	95									

TABLE 13

MEAN MASS CONSERVATION SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]

(N=143)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.25	4.00	4.12	3.78	3.75	3.76	3.62	3.40	3.54
6	5.75	5.37	5.56	4.75	4.22	4.47	4.12	2.88	3.50
7	6.12	4.38	5.25	4.50	4.12	4.31	5.00	4.75	4.88
Mean All Ages	5.38	4.58	4.98	4.32	4.04	4.18	4.25	3.71	4.00

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 14

PERCENTAGE[a] OF PERFECT MASS CONSERVATION SCALE TYPES

AMONG BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[b]

(N=139)

	Age	ITEMS							
		0	1	2	3	4	5	6	7
Bright									
(N=16)	5	00	00	31	25	06	07	00	31
(N=16)	6	00	00	12	13	06	07	00	62
(N=16)	7	00	00	19	12	06	07	00	56
Average									
(N=16)	5	00	00	12	38	19	19	06	06
(N=17)	6	00	00	35	06	12	06	06	35
(N=14)	7	00	00	35	22	00	00	07	36
Retarded									
(N=13)	5	00	00	30	23	31	00	08	08
(N=16)	6	00	00	56	00	19	06	00	19
(N=15)	7	00	00	27	06	13	06	07	41

[a]Underlined percentage indicates that 75% of Ss at that age are at or above the level in which the percentage falls.

[b]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 15

PERCENTAGE[a] OF MASS CONSERVATION SCALE SCORES

AMONG BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[b]
(N=142)

			SCALE ITEMS							
		Age	0	1	2	3	4	5	6	7
BRIGHT	(N=16)	5	00	00	<u>31</u>	25	06	07	00	31
	(N=16)	6	00	00	12	13	<u>06</u>	07	00	62
	(N=16)	7	00	00	19	12	<u>06</u>	07	00	56
AVERAGE	(N=16)	5	00	00	12	<u>38</u>	19	19	06	06
	(N=17)	6	00	00	<u>35</u>	06	12	06	06	35
	(N=16)	7	00	00	<u>31</u>	19	06	07	06	31
RETARDED	(N=13)	5	00	00	<u>30</u>	23	30	00	08	09
	(N=16)	6	00	00	<u>56</u>	00	19	06	00	19
	(N=16)	7	00	00	25	<u>06</u>	12	07	12	38

[a]Underlined percentage indicates that 75% of Ss at that age are at or above the level in which the percentage falls.

[b]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 16

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] WHO SUCCEED ON EACH MASS CONSERVATION SCALE ITEM

			1	2	3	4	5	6	7
BRIGHT	(N=16)	5	100	100	69	44	38	31	31
	(N=16)	6	100	100	88	75	69	62	62
	(N=16)	7	100	100	81	69	62	56	56
AVERAGE	(N=17)	5	100	100	88[b]	50	31	12	6
	(N=17)	6	100	100	65	53	47	41	35
	(N=16)	7	100	100	69	44	44	44	31
RETARDED	(N=13)	5	100	100	69	53	15	15	8
	(N=16)	6	100	100	44	44	25	19	19
	(N=16)	7	100	100	75	69	50	50	44

[a]Bright and Average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b]N=16

TABLE 17

FREQUENCY OF SCALE SCORES ATTAINED BY SUBJECTS RETESTED AFTER ONE YEAR (N=19)

First Testing Scale Score	Second Testing Scale Score							
	0	1	2	3	4	5	6	7
0								
1								
2			2	2				1
3			2		1	1		1
4								1
5					1	1		
6				1			1	
7								4

Ss remained at the same level the second year as the first year. Seven Ss performed at a higher level the second year, and four Ss appear to have regressed. More longitudinal data is needed to ascertain whether this sequence can be viewed as one which individuals must pass through in an invariant fashion. However, for most of the Ss retested, the scale can account for their developmental progression.

Effect of IQ on Performance

Although Table 12 suggests that bright children may be superior to average IQ children with regard to their ability to conserve mass, the difference is not statistically significant ($F = 3.57, df=1,83, p < .06$). Neither are average IQ children shown to be superior to retarded children of the same mental age ($F = .32, df=1,86, p < .57$). Therefore, during the ages 5-7 years both bright and average children appear to be at about the same level of development, both with quite a long way yet to develop. The same finding applies to the comparison of average and retarded Ss. When mental age is controlled, a higher IQ is no advantage in this developmental task, at the age levels studied.

Effect of Sex on Performance

No sex differences were found on this task, although mean performance of girls is below that of boys for all ages in all IQ groups. The differences are insignificant between girls and boys in the retarded and average groups ($F = .92, df=1,83, p < .34$), as well as in the average and bright groups ($F = 1.59, df=1,86, p < .21$). No interactions with sex appeared.

Test Item Difficulty and Decalage

Comparison of individual performance on the three conservation questions asked suggests that Ss tend to be consistently conservers or nonconservers, but that Piaget (1941) appears to be correct in noting that a transitional period exists where conservation is possible in one situation but not in

another where the apparent transformation is intensified in its effect. Table 18 compares responses to the transformation of the small ball into the "sausage" (Q1) with the limits-testing transformation of the sausage into the longer "snake." Of 139 Ss clearly scorable on both, 125 Ss were consistent in their responses; they either passed both or failed both. However, 11 Ss who correctly selected the ball when the "sausage" was formed could not maintain their conservation when the sausage was elongated into a "snake." The 3 Ss who failed the "sausage" but passed the "snake" were extremely uncertain and vacillating in their correct choice of the ball in comparison to the snake.

Comparison of responses to the "sausage" (Q1) and to the "pancake" (Q2) transformations (See Table 19) shows that the "pancake" transformation is somewhat easier. Of the 19 Ss inconsistent in their responses to those questions, 16 Ss succeeded in conserving on the "pancake" transformation, but failed on either the "sausage" or "snake" transformation. In light of the fact that the order of presentation did not seem to make the "snake" transformation easier than the "sausage," an explanation in terms of an artifactual order effect seems unwarranted. The most parsimonious explanation seems to involve the fact that the "pancake" is virtually one-dimensional while the "sausage" and "snake" are more two-dimensional. If the child is trying to coordinate two dimensions, the fact that only one exists for the "pancake" will make it much easier for him.

Decentration

One puzzling occurrence was that many Ss seemed to believe that both the transformed and the untransformed candy were greater in some way. For example, this was expressed by choice of the transformed candy as having more to eat but choice of the untransformed candy as "bigger." Since such inconsistency might occur as a result of semantic confusion of the part of

TABLE 18

COMPARISON OF RESPONSES TO "SAUSAGE" AND "SNAKE" TRANSFORMATIONS:

FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS PASSING AND FAILING

(N=139)

"Snake"	"Sausage"							
	Bright (N=47)		Average (N=49)		Retarded (N=43)		All Ss (N=139)	
	+	-	+	-	+	-	+	-
+ (Pass)	22	0	11	3	13	0	46	3
- (Fail)	5	20	4	32	2	28	11	79

TABLE 19

COMPARISON OF RESPONSES TO "PANCAKE" AND "SAUSAGE-SNAKE" TRANSFORMATIONS: FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS PASSING AND FAILING

(N=139)

"Pancake"	"Sausage-Snake"							
	Bright (N=47)		Average (N=49)		Retarded (N=43)		All Ss (N=139)	
	+	-	+	-	+	-	+	-
+ (Pass)	21	5	11	9	11	2	43	16
- (Fail)	1	20	0	29	2	28	3	77

the child, the tendency to say that both are greater is investigated in terms of whether it is accompanied by inconsistency in choice of which has "more to eat." Tables 20 and 21 show the frequency of conservers and nonconservers in each IQ group who answer in synonymous and non-synonymous fashion to the questions "more to eat" and "bigger" on the "sausage-snake" and "pancake" transformation. While a predominant number of both conservers and nonconservers tend to think of "more to eat" and "bigger" synonymously, a larger proportion of nonconservers (32% and 24%, respectively, on "sausage-snake" and "pancake") responded differently to these questions than did conservers (4% and 13%, respectively). While this view of "more to eat" and "bigger" as non-synonymous may reflect a verbal confusion, this seems unlikely, as the language used is not difficult. Also, if this were the proper explanation, one would expect a greater proportion of retarded Ss to show the confusion, and they do not. It seems that an explanation in terms of a S's focussing on one dimension and then on another without recognizing the contradiction in his judgments may be in order.

TABLE 20

FREQUENCY OF CONSERVERS AND NONCONSERVERS ON SAUSAGE-SNAKE QUESTION WHO BELIEVE "BIGGER" AND "MORE TO EAT" ARE SYNONYMOUS

Belief about which is bigger and which has more to eat	Bright (N=47)		Average (N=50)		Retarded (N=45)		All Ss (N=142)	
	Con.	Non.	Con.	Non.	Con.	Non.	Con.	Non.
Synonymous	24	14	15	22	12	25	51	61
Non-synonymous	0	9	1	12	1	7	2	28

TABLE 21

FREQUENCY OF CONSERVERS AND NONCONSERVERS ON PANCAKE QUESTION

WHO BELIEVE "BIGGER" AND "MORE TO EAT" ARE SYNONYMOUS

Belief about which is bigger and which has more to eat	Bright (N=48)		Average (N=50)		Retarded (N=45)		All Ss (N=143)	
	Con.	Non.	Con.	Non.	Con.	Non.	Con.	Non.
Synonymous	20	17	13	24	13	26	46	67
Non-synonymous	4	7	3	10	0	6	7	23

CONSERVATION OF NUMBER

METHOD

The number conservation problem posed here is based on similar situations utilized by Piaget (1952) in his studies of children's number concepts. However, the test materials differ from those used by Piaget in that they were M&M chocolate candies which provided an added motivational dimension.

Procedure

Six circular cardboard pizza plates 14-inches in diameter were prepared with M&M's perpendicular to the child's line of sight and covered with napkins. The S was seated at the desk in front of the first pair of plates.

The pre-test discrimination item was designed to obtain a basal level of response latency in a situation likely to elicit no conflict. Eight equally-spaced brown M&M's on the plate to the child's left were in a row 14 inches long, and seven brown M&M's on the plate to the child's right were placed from top to bottom in one-to-one correspondence to the M&M's on the other plate. E said:

> I have some candy on these plates. One plate has more than the other plate. In a minute I'm going to ask you to pick the plate that has more candy to eat. If you can show me the plate that has more to eat, you can have it to keep or to eat. But if you don't pick the plate that has more candy to eat, you won't get any candy this time, but you'll get another chance later. Now, look at both of them and show me the plate that has more candy to eat (napkins are simultaneously removed).

The S was allowed to put the eight M&M's in his sack, and the plates were removed.

Test item 1 was designed to find whether the S could conserve the quantity six when a constriction of length transformed six M&M's into a shorter line than five M&M's. Two napkin-covered plates were presented on the desk in front of S. Six equally-spaced red M&M's on the plate to the child's left were in a line 12 inches long, and five M&M's on the plate

to the child's right were in a line 8 inches long (both lines centered on their plates). E said:

> I have some more candy on these plates. Which has more to eat (napkins simultaneously removed)? That's right. Now, in a minute when I say so, you may pick the plate with the most candy--the one that has more to eat--to keep or to eat. If you don't pick the one that has more candy to eat, you won't get any candy this time, but you'll get another chance to pick some later. Before you pick, I put them like this (the six M&M's are constricted into a line $4\frac{1}{2}$ inches long). Now look at both plates (E touches both plates) and if you can show me the plate that has more candy to eat, you may have it.
>
> How did you know that was more?
> Which plate had more before?

S was allowed to take the candy from the plate he selected.

Test item 2 elicited counting and explored the child's comparative use of counting as an aid to conservation. Two napkin-covered plates were presented. Six equally-spaced yellow M&M's on the plate to the child's right were centered on the plate in a line four inches long, and five yellow M&M's on the plate to the child's left were in a line eight inches long. E said:

> I have some candy on these plates. One plate has more than the other plate. When I say so, you may pick the plate with the most candy--the one that has more to eat--to keep or to eat. If you don't pick the one with the most candy, you won't get any candy this time. You'll get another chance later. Now, if you can show me the one that has more candy to eat, you may have it (napkins simultaneously removed).
>
> How could you tell which had more candy to eat?

If S did not count, E said, "If I thought this one (plate not selected by S) had more to eat, how could you show me it doesn't?" If S still did not count, E asked, "Could you count them?" If S counted only one plate, he was asked to count the other. If he counted incorrectly, he was asked to count again so that his result was correct. After counting to six on one plate and to five on the other, E asked, "So which has more candy to eat?"

Test item 3 was used with Ss who failed either item 1 or 2, in order

to determine whether the counting experience and an explicit corrective statement by E would result in a conservation conclusion. E rearranged the six M&M's into a line twelve inches long, saying,

> "See, there are 1, 2, . . . 6 here, and 1, 2, . . . 5 here. This one (pointing to plate with six) has more. Now watch. I'm going to put them like this (six M&M's were again constricted into a line four inches in length). Now look at both plates and show me the plate that has more candy to eat."
>
> How did you know that had more to eat?
> Which plate had more before?

Scoring

Subjects were scored as passing (+) or failing (-) each of the following items:

1. Can count correctly to 6

   +: Counts from 1 to 6 correctly at some point or says plate has 6.

2. Remembers which plate had more before the change in the array

   +: a. Answers memory Q correctly (which plate had more before?).
   b. Picks 6 M&M's after constriction of length on Q1b.
   c. Spontaneously verbalizes fact that it had more before.

3. Knows which plate has more when 8 M&M's are arranged in one-to-one correspondence with 7 M&M's.

   +: Selects plate with 8.

4. Knows 6 is more than 5, numerically

   +: a. Picks 6 on Q2 after counting (when 6 are in shorter line).
   b. Spontaneously verbalizes fact, e.g., "This is 6 and that only has 5," "This is 5 and this is 6," as justification for selecting 6.
   c. Picks 6 on Q3 after recounting.
   d. Says 6 has more candy on 2b (so which has more? immediately after counting).

5. Conserves after counting help and lengthening of greater quantity to greater length

   +: a. Picks 6 on Q3 without recounting after change in array.
   b. If this item not given, + if conserves without help.

6. Ever conserves without help

   +: Takes or chooses 6 on Q1.

Note: This item is intended to differentiate those subjects who make only inconstant responses from those who are inconstant but who change their mind at some point and make a constant response.

7. Believes quantity doesn't really change

+: a. Says the 6 M&M's didn't really get to be less or the 5 didn't really get to be more.
b. If question not asked, but S conserves.
c. Says 6 got less or 5 got more but contradicts and elaborates in such a way as to indicate that original question was not understood.

Note: - is scored when S spontaneously verbalizes that (6) had more before, but (5) has more after change in array, regardless of answer to "really change" Q.

8. Conserves consistently

+: Correctly picks 6 on Q1 after constriction of length and without recounting and makes no inconstant choices thereafter.

Note: Choosing 5 on Q2 is not considered an indication of inconstancy since 2a is not a text of constancy, i.e., there is no change in the array.

b. Picks 5 on Q1 but spontaneously changes to 6 and takes 6.

9. Conserves with certainty

+: a. Does not hesitate, vacillate, or change mind in making constant choice.
b. Does not recount after change in array.

In addition, S's verbal reasons were scored as follows:

Reasons verbalized for nonconservation

1. Irrelevant reason or no reason given, e.g., "It's more," "It looks bigger."
2. The quantity relationship changed because E moved the M&M's.
3. Supernatural cause; magic.
4. Centration on length, e.g., "It's longer (referring to line of five M&M's)"
5. Illogical (merely descriptive) numerical reference, e.g., "This is six and this is five (but says the row of five has more to eat)"
6. Illogical (merely descriptive) reference to distance between M&M's,

e.g., "These are closer together, and these are farther apart (but says the row of five has more to eat)"

Reasons verbalized for conservation

7. Irrelevant reason or no reason given, e.g., "It's more," "It looks bigger."
8. Appearance is irrelevant with regard to quantity, e.g., "It just looks like more," "Making it longer (or spreading them out) doesn't make it more."
9. Identity, e.g., "It was more before," "It was more/less before, and it will still be more/less."
10. Empirical reversibility, e.g., "If you put them back the way they were before, they would still be the same," "If you would spread that one (greater quantity in shorter line) out, it would be more."
11. Compensation of relations, e.g., "It's longer, but more pushed in."
12. Addition-subtraction principle, e.g., "You can't make it more unless you add some more M&M's," "It can't change unless you take some away."
13. Generalization of conservation principle, e.g., "It stays the same, no matter what you do," "It wouldn't change," "It's six and that's five," "I counted them, so I know it's more."

RESULTS

Developmental Sequence

The foregoing set of items can be said to describe an invariant developmental sequence of acquisition, on the basis of the following evidence:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis using Green's (1956) summary statistics was performed which indicates that the nine dichotomous items form a Guttman scale (Table 22 shows reproducibilities and indices of consistency). Table 23

TABLE 22

SCALOGRAM ANALYSIS OF NUMBER CONSERVATION

Ratios Computed	Bright	Average	Retarded
Reproducibility	.99769	.98223	.98025
Chance Reproducibility	.93678	.88223	.87235
Index of Consistency	.96346	.84983	.83897

presents the ten perfect scale patterns possible and indicates the number of Ss in each ability group found for each scale type.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 24 indicates that lower scale scores are obtained more frequently by five-year-olds and higher scores are obtained more frequently by six- and seven-year-olds in the bright and average groups. This is reflected in an increase in mean scale score after age five, but in little change from age six to seven years, as shown in Table 25, although this age change is statistically significant ($F=4.22$, $df=2,86, p < .02$). Consistent with this are the findings shown in Table 26 which indicate that smaller proportions of five-year-olds succeed on each scale item. The decreasing percentages of Ss at each age level who succeed on items increasing in difficulty also suggest that the scale describes an age-wise progression.

3. Retesting of Ss after one year shows a general progression along the scale. Table 27 indicates that of 19 Ss retested after one year, 16 either performed at the same or higher levels, with only 3 Ss scoring at a lower level the second year.

The foregoing findings combine to show that the sequence from easiest to hardest on the scale is an age-wise progression which appears to occur in a regular order. More definitive evidence would be provided by a broader age range of Ss inasmuch as no Ss in this age range scored at the lower levels, and the sample was not extended to the age at which all Ss perform at the highest level. Detailed evidence on the longitudinal progression of individual children is needed to ascertain whether all the steps included in the developmental sequence described by the scale are essential for acquisition of number conservation.

TABLE 23

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT EACH NUMBER CONSERVATION SCALE LEVEL (N=143)

	ITEMS									BRIGHT			AVERAGE			RETARDED		
Scale Type	1	2	3	4	5	6	7	8	9	Scale Type	Non Scale Type	Med. Age-Sc. Ty.	Scale Type	Non Scale Type	Med. Age-Sc. Ty.	Scale Type	Non Scale Type	Med. Age-Sc. Ty.
9	+	+	+	+	+	+	+	+	+	33	0	80	19	0	79	11	0	110
8	+	+	+	+	+	+	+	+	-	6	0	78	1	0	78	5	1	113
7	+	+	+	+	+	+	+	-	-	0	1	-	0	1	-	0	0	-
6	+	+	+	+	+	+	-	-	-	1	0	63	3	2	75	2	1	99
5	+	+	+	+	+	-	-	-	-	2	0	71	5	2	72	7	1	96
4	+	+	+	+	-	-	-	-	-	3	0	68	10	2	82	4	4	104
3	+	+	+	-	-	-	-	-	-	1	0	61	5	0	67	7	0	110
2	+	+	-	-	-	-	-	-	-	1	0	89	0	0	-	1	1	91
1	+	-	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
0	-	-	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
n	143	142	141	120	91	90	84	78	64	47	1		43	7		37	8	
$\bar{n}$	0	1	2	23	52	53	59	65	79									

TABLE 24

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED CHILDREN SCORING AT TEN NUMBER CONSERVATION SCALE LEVELS (N=143)

Ability Group	Age	Scale Items 0	1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	00	00	00	06	19	07	06	00	12	50
	6 (N=16)	00	00	00	00	00	06	00	00	13	81
	7 (N=16)	00	00	06	00	00	00	00	07	12	75
Average	5 (N=17)	00	00	00	24	24	18	06	00	00	28
	6 (N=17)	00	00	00	06	24	06	18	00	06	40
	7 (N=16)	00	00	00	00	25	19	06	06	00	44
Retarded	5 (N=13)	00	00	15	16	16	30	08	00	15	00
	6 (N=16)	00	00	00	07	31	12	13	00	06	31
	7 (N=16)	00	00	00	25	06	12	00	00	19	38

TABLE 25

MEAN NUMBER CONSERVATION SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=143)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	7.12	7.12	7.12	3.89	7.38	5.53	4.88	4.20	4.62
6	8.50	8.75	8.62	6.50	6.78	6.65	6.12	6.12	6.12
7	8.88	7.75	8.31	6.88	6.50	6.69	6.00	7.00	6.50
Mean All Ages	8.17	7.88	8.02	5.68	6.88	6.28	5.67	6.00	5.14

[a]Bright and Average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 26

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED CHILDREN SUCCEEDING ON EACH NUMBER CONSERVATION SCALE ITEM AT THREE AGES[a] (N=143)

Ability Group	Age		Scale Items 1	2	3	4	5	6	7	8	9
Bright	5	(N=16)	100	100	100	94	75	69	76[b]	62	50
	6	(N=16)	100	100	100	100	100	94	94	94	81
	7	(N=16)	100	100	94	94	88	94	94	94	81
Average	5	(N=17)	100	100[c]	94	75[c]	50[c]	41	62[d]	29	29
	6	(N=17)	100	100[c]	100	94	71	59	60[e]	47	41
	7	(N=16)	100	100	100	100	56	56	62	50	44
Retarded	5	(N=13)	100	92	92	46	61	30	08[f]	15	08
	6	(N=16)	100	100	100	75	69	56	44	38	31
	7	(N=16)	100	96	100	75	62	62	57[g]	56	38

[a] Bright and Average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=13

[c] N=16

[d] N= 8

[e] N=15

[f] N=12

[g] N=14

TABLE 27

FREQUENCY AND DIRECTION OF CHANGE IN NUMBER CONSERVATION SCALE SCORE AMONG SUBJECTS RETESTED AFTER ONE YEAR (N=19)

Score at First Testing	Score at Second Testing										
	0	1	2	3	4	5	6	7	8	9	10
0											
1											
2											
3											
4						2		1			
5							1				3
6											2
7						1					1
8											
9											
10								2			6

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis performed separately for each IQ group indicated that the order of difficulty of scale items does not vary for groups differing in IQ. Table 22 shows that the items form a Guttman scale for bright, average, and retarded children.

Level of Performance

High IQ is associated with better performance on this number conservation task. Tables 24-26 show that bright children perform at a consistently higher level than average or retarded children, but that there is little difference between average and retarded children. An analysis of variance between performance of bright and average groups showed a significant difference attributable to IQ ($F=18.36, df=1,86, p < .0001$), but no significant difference in performance was found between average and retarded groups ($F=1.16, df=1,83$). However, since mental age is controlled in the comparison between average and retarded groups, the significant age effect ($F=3.44$, $df=2,83, p < .04$) reflects the potency of mental age as a performance factor. Thus, mental age appears to be a more potent factor than IQ in acquisition of number conservation.

Sex Differences

Table 25 indicates that there are no sex differences in number conservation performance for bright children until age seven when boys perform at a higher level. For average children, girls are superior to boys at age five but are comparable in performance at six and seven years. The analysis of variance results shows a significant interaction between age and sex ($F=13.29, df=2,86, p < .04$) for bright and average groups. In the comparison of average and retarded groups, sex alone approaches significance as a performance factor ($F=2.98, df=1,83, p < .09$), and the interaction among sex,

age, and IQ also approaches significance ($F=2.91, df=2,83, p$ .06). Thus, it appears that while the developmental progress of girls toward number conservation is as good or better than that of boys at ages five and six, by age seven, this is no longer so, and bright girls suffer more in this developmental comparison with boys than do average girls. For retardates, a reverse trend appears to exist inasmuch as at mental age seven, girls perform at a higher level than do boys.

CLASS INCLUSION

METHOD

The procedure used to investigate understanding of the inclusion relation was based upon work by Piaget (]952). Materials utilized are four chocolate M&M's and one white mint comparable in size to that of the M&M's.

Procedure

The child was seated at a small desk. E placed the mint and the four M&M's on the desk and asked the following series of questions.

Item 1 was designed to provide S with the verbal labels "chocolate candy" and "mint candy" in case he did not possess these, to indicate to S that both chocolate and mint are subclasses of a larger class of candy, and to present the inclusion question. Slowly and clearly, E said:

> Look, here is some candy. Some are chocolate candy, and one is mint candy. Are these chocolate candy (pointing to M&M's)? Is this mint candy (pointing to mint)? Now, I'm going to have you pick some, and you must pick the most you can. If you don't pick what has more to eat, you won't get any candy this time. Now, pick either all the chocolate or all the candy. Why did you pick that? Which are there more of, chocolate or candy? Why is that?

Item 2 was included in order to explore the ability to identify the whole and the larger subclass with the proper verbal labels. E held out an open palm to S and said:

> Put all the candy in my hand.
> Put all the chocolate in my hand.

Items 3 and 4 were designed to investigate the ability to recognize that the whole includes each subclass and is greater than each. It was expected that these questions might assist some Ss in revising an incorrect response to Item 1. E asked:

Item 3: Is all the candy chocolate?
Is all the candy mint?
Is some of the candy chocolate?
Is some of the candy mint?

Item 4: Now, listen carefully. If you took some of the chocolate away, would there be any chocolate left?

If you took all of the chocolate away, would there be any chocolate left?

If you took all of the chocolate away, would there be any candy left?

If you took all of the candy away, would there be any chocolate left?

Item 5 was designed to ascertain whether the experience in Items 3 and 4 did assist S in revising an incorrect inclusion response. E said, "Then is there more candy or more chocolate? Why do you say there would be more _____?

Item 6 was included in order to ascertain whether S was viewing both subclasses as complementary parts of the whole. E asked, "What kind of candy is here?"

Item 7 finally offered S one last opportunity to obtain all five candies by correctly answering the inclusion question. E said, "You take either all the chocolate or all the candy--whichever has more to eat--and put it in your sack.

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. Knows referents for "all the candy" and "all the chocolate"

   +: Responds correctly when asked to "Put all the candy in my hand" and "Put all the chocolate in my hand" on Question 2.

2. Understands "all" and "some" (enveloping class and subclass)

   +: Responds correctly when asked whether all the candy is chocolate/mint and whether some of the candy is chocolate/mint on Question 3.

3. Knows that the whole is comprised of two parts (complementarity)

   +: Responds correctly when asked what kind of candy is present on Question 6.

4. Says there is more candy than chocolate at some point

5. Knows there is more candy than chocolate after the help questions

   +: Takes all the candy at the end of the task on Question 6.

6. Knows there is more candy without help (includes)

   +:, Responds correctly to whether there is more candy or more chocolate on Question 1.

Note: "Candy" must refer to all five items, not to mint.

In addition, verbalized reasons were scored as follows:

Non-Inclusion Reasons:

1. Irrelevant reason or no reason given, e.g., "Because I like it," "Chocolate is good," "I don't like mint," "I looked at it," "This is chocolate and that's white."
2. Graphic impression, gross or intuitive comparison (non-numerical), e.g., "It's a whole bunch," "It's a lot," "Because all the M&M's together are bigger than one mint," "You can eat chocolates longer," "You can suck the mint longer," "Because it has more."
3. Numerical comparison of A (chocolates) with A' (mint), e.g., "Because there are four M&M's and one mint."

Inclusion Reasons:

4. Non-logical or no reason given, e.g., "Chocolate is not sweet," "Because the chocolate and the mint have lots of taste to it."
5. Focus on whole class (B), e.g., "All of it, it's five," "Because all together it's more," "All together it's bigger."
6. More than A is more than A, e.g., "Because there's one mint and four chocolates. If I had four and add one, I'l have more."
7. Comparison of subclass A (chocolates) with the whole B, e.g.,

   B is more than A: "Five is more than four." "There's more candy than chocolates," "All the chocolates aren't all the candy," "There are five candies and only four chocolates, and the mint makes five," M&M's are less (not enough) than all the candy."

   B-A= 0: "Because then it would be all gone," "It won't be all

gone if you eat only the chocolate/mint," "There's something left over after you take out the chocolate/mint."

RESULTS

Several lines of evidence suggest that the set of items presented above can be accepted as a description of an invariant developmental sequence of acquisition of inclusion ability:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis using Green's (1956) summary statistics was performed which indicates that the six dichotomous items form a Guttman scale (See Table 34 for reproducibilities and indices of consistency). Table 35 shows the seven perfect scale patterns possible and indicates the number of Ss in each ability group found for each scale type.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Median age of perfect scale types show a general increase with increase in scale score. Table 36 indicates that younger children tend to score at the lower scale levels and that older children tend to score at the higher levels. This is reflected in an increase in mean scale scores with increasing age for bright and average groups as shown in Table 37. An analysis of variance finds age a significant factor in performance ($F=15.38, df=2,86, p < .0001$ for bright and average groups). More specifically, the age-developmental character of the scale is indicated by Table 38 which shows that the proportion of Ss passing each scale item increases with age in a regular fashion.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 39 indicates that of 19 Ss retested after one year, 15 either performed at the same of higher level, and that only 4 Ss scored at a lower level the second year.

TABLE 34

RESULTS OF SCALOGRAM ANALYSIS[a] OF CLASS INCLUSION FOR BRIGHT, AVERAGE, AND RETARDED GROUPS

Ratios Computed[a]	Bright (N=47)	Average (N=48)	Retarded (N=45)
Reproducibility	.98937	.97223	.97408
Chance Reproducibility	.91860	.91694	.90931
Index of Consistency	.86941	.66566	.71419

[a]Using Green's (1956) summary statistics

TABLE 35

MEDIAN AGE AND FREQUENCY OF SCORES ON SCALE OF DEVELOPMENT OF CLASS INCLUSION ABILITY FOR BRIGHT, AVERAGE, AND RETARDED SUBJECTS (N=143)

	SCALE ITEMS						BRIGHT			AVERAGE			RETARDED		
Scale Type	1	2	3	4	5	6	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
6	+	+	+	+	+	-	17	-	88	8	-	93	6	-	101
5	+	+	+	+	-	-	9	1	82	5	0	87	8	0	115
4	+	+	+	-	-	-	0	0	0	3	1	84	0	1	-
3	+	+	+	-	-	-	18	0	70	22	2	76	21	1	105
2	+	+	-	-	-	-	1	2	75	4	3	79	2	3	105
1	+	-	-	-	-	-	0	0	-	0	2	-	1	1	80
0	-	-	-	-	-	-	$\frac{0}{45}$	$\frac{0}{3}$	-	$\frac{0}{42}$	$\frac{0}{8}$	-	$\frac{1}{39}$	$\frac{0}{6}$	91
n	139	129	127	58	55	30									
$\bar{n}$	1	11	13	82	85	110									

TABLE 36

PERCENTAGE OF CLASS INCLUSION SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=143)

Ability Group	Age	0	1	2	3	4	5	6
Bright	5 (N=16)	00	00	06	75	00	13	06
	6 (N=16)	00	00	13	31	00	25	31
	7 (N=16)	00	00	00	06	00	25	69
Average	5 (N=17)	00	00	12	24	52	12	00
	6 (N=17)	00	00	06	70	06	12	06
	7 (N=16)	00	00	12	19	06	19	44
Retarded	5 (N=13)	08	08	23	61	00	00	00
	6 (N=16)	00	00	06	50	06	13	25
	7 (N=16)	00	06	06	38	00	38	12

TABLE 37

MEAN CLASS INCLUSION SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=143)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	3.25	3.50	3.38	2.67	2.62	2.65	2.38	2.40	2.38
6	3.75	4.88	4.31	3.38	3.44	3.41	3.88	4.12	4.00
7	5.38	5.75	5.56	4.88	4.38	4.62	3.25	4.62	3.94
Mean All Ages	4.12	4.71	4.42	3.60	3.48	3.56	3.17	3.90	3.44

[a] Bright and average subjects are grouped according to chronological age, and retarded subjects are grouped according to mental age.

TABLE 38

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED AT THREE AGES[a] SUCCEEDING ON EACH CLASS INCLUSION SCALE ITEM (N=143)

Ability Group	Age		1	2	3	4	5	6
Bright	5	(N=16)	94	100	93	19	19	12
	6	(N=16)	94	100	94	56	56	31
	7	(N=16)	100	100	100	94	94	6
Average	5	(N=17)	82	71	76	24	12	00
	6	(N=17)	94	100	100	24	18	06
	7	(N=16)	100	100	86	69	62	44
Retarded	5	(N=13)	84	61	84	00	08	00
	6	(N=16)	100	94	94	44	44	25
	7	(N=16)	94	100	88	50	50	12

[a]Bright and average subjects are grouped according to chronological age, and retarded subjects are grouped according to mental age.

TABLE 39

Score at First Testing	Score at Second Testing						
	0	1	2	3	4	5	6
0							
1							
2				1		1	1
3			3	7		4	
4				1			1
5							
6							

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis performed separately for each ability group indicates that the order of difficulty does not vary for groups differing in IQ. Table 34 shows that the six items constitute a scale for bright, average, and retarded groups. Thus, the sequential order of acquisition of class inclusion ability is the same for these three IQ groups.

Level of Performance

While IQ significantly enhances the performance of bright Ss in comparison to average Ss ($F=13.04, df=1,86, p < .0006$), it does not provide average Ss with an advantage over retarded Ss of the same mental age ($F=.16, df=1,83, p < .69$). Table 37 shows that the mean performance level of bright Ss is higher than that of average Ss at every age level whereas average Ss do not consistently perform at levels higher than retardates. The interaction between mental age and IQ for average and retarded groups approaches significance ($F=2.15, df=2,83, p < .12$). Retardates of the same mental age as average children perform comparably at mental ages five and six (with retardates even showing some superiority at mental age six), but perform less well on the whole at mental age seven. However, retarded girls show higher levels of performance than both retarded boys and average Ss at mental ages six and seven; the sex-IQ interaction also approaches significance ($F=2.13, df=2,83, p < .15$).

Sex Differences

Some tendencies for bright and retarded girls to perform at a higher level than boys were found, but none of these are significant. Bright girls at all ages, but expecially at age six, perform at a higher level than bright boys. Retarded girls, particularly at mental age seven,

obtain higher mean scale scores than do retarded boys. Performance of average boys and girls is comparable, but girls do somewhat more poorly at age seven.

CONSERVATION OF CONTINUOUS QUANTITY

METHOD

The investigation of the development of conservation of continuous quantity is based on Piaget's (1952) work in this area. However, motivation was enhanced by the use of Coco-Cola as the material transformed.

Procedure

The first two problems were designed to assess the S's expectancy of constancy in the amount of continuous quantity. The child was seated at a table whose top was at his eye level. He was asked to predict which container held more Coke when the result of a transformation was invisible.

Prediction Question A: Two transparent 10 ml beakers and one green opaque 100 ml beaker were placed on the table at the S's eye level, with the 100 ml beaker to his right and the two 10 ml beakers adjacent to his left. E said:

> Do you like Coke? I'm going to put some Coke in these glasses. After while we'll drink some. (E poured Coke in both 10 ml beakers, filling the beaker to the S's left to the top, but filling the 10 ml beaker next to the large opaque beaker only half-full.) Now, when I say so, you can pick the one that has more to drink. If you don't pick the one with more to drink, you won't get to drink any this time, but you'll get another chance to drink some later. Now, before you pick, I take this one (10 ml beaker with more Coke) and pour it all out into this one (100 ml beaker). If you can show me the one with more Coke to drink, you may have it to drink. (E placed a 3" x 5" card on top of opaque beaker so S could not look inside.)
>
> How did you know that had more to drink?
> Which of these (pointing to two 10 ml beakers) had more to drink before I poured any here (pointing to 100 ml beaker)?
>
> Can you show me on this glass (pointing to 100 ml beaker) where the Coke inside comes? See, this Coke (10 ml beaker with less Coke) comes to here (pointing to top of liquid). Where does the Coke in here (100 ml beaker) come? How do you know it would come to there? (S was allowed to drink the Coke with a straw from the container he chose.)

Prediction Question B: Two transparent 10 ml beakers and one green opaque 5 ml graduate were placed at the S's eye level, with the graduate to his right and the two beakers adjacent to his left. E said:

Now, let's fill these glasses. Now I fill this glass (10 ml beaker next to the graduate) up to the very top. I don't fill this (other beaker) glass up. Now, see, I put more Coke in one glass than the other. When I say so, you can pick the one with more to drink. If you don't pick the one with more Coke to drink, you won't get to drink any this time, but you'll get another chance to drink some later. Now, before you pick, I take this one (beaker with lesser amount) and pour the Coke all out into this one (graduate). (E placed 3" x 5" card on top of opaque graduate so S could not look inside.) If you can show me the one with more Coke to drink, I'll give it to you to drink. How did you know that had more to drink?

Which of these (pointing to two beakers) had more to drink before I poured any in here (pointing to graduate)?

Can you show me on this glass (pointing to graduate) where the Coke comes? See, this Coke (beaker with greater amount) comes to here (pointing to top of liquid). Where does the Coke in here (graduate) come? (E provided a straw so that S could drink the Coke from the container he chose.)

Item 1 was designed to assess the S's ability to conserve when faced with the transformation resulting from pouring the greater content of the 10 ml beaker into a wider 100 ml beaker. (This item is identical to Prediction Question A, except that the transformation result was visible.) Two transparent 10 ml beakers and one transparent 100 ml beaker were placed on the table at the S's eye level, as in Prediction Question A. E said:

Now, I'm going to put some Coke in these glasses. After while we'll drink some. (E poured Coke in both 10 ml beakers, filling the beaker to the S's left to the top, but filling the other 10 ml beaker only half-full.) You don't need to show me, but can you see that I put more Coke in one glass than the other? When I say so, you can pick the one with more Coke to drink. If you don't pick the one with more to drink, you won't get to drink any this time. You'll get another chance to drink some later. Now, before you pick, I take this one (beaker with more Coke) and pour the Coke all out into this one (100 ml beaker). Now, look at them. If you can show me the one with more Coke to drink, you may have it to drink. How could you tell that had more to drink?

If S said he knew because the empty beaker had more (or the filled one had less), E asked, "But how can you tell now when it's like this (pointing to 100)?"

If S said, "Because it was more," E asked, "When was it more?"

(E provided a straw so that S could drink the Coke from the container he chose.)

Item 2 was designed to assess the S's ability to conserve when faced with the transformation resulting from pouring the lesser content of the 10 ml beaker into a narrower, 5 ml graduate. (This item is identical to Prediction Question B, except that the transformation result was visible.) Two transparent 10 ml beakers and one transparent 5 ml graduate were placed on the table at the S's eye level, as in Prediction Question B. E said:

> Now, let's fill these two glasses. I fill this one (beaker next to graduate) up to the very top. I don't fill this (other beaker) one up. Now, see, I put more Coke in one glass than the other. You don't need to show me, but can you see that one has more Coke to drink. If you don't pick the one that has more Coke to drink, you won't get to drink any this time. You'll get another chance to drink some later. Now, before you pick, I take this one (beaker with lesser amount) and pour the Coke all out into this one (graduate). Now, look at them. If you can show me the one with more Coke to drink, you may have it to drink. How could you tell that had more to drink?
>
> If S said he knew because the empty beaker had less (or the filled one had more), E asked, "But how can you tell when it's like this (pointing to graduate)?
>
> If S said, "Because it was more," E asked, "When was it more?" (If S was correct, E permitted S to drink the Coke he chose.)

Item 2a was provided as a control for the possibility that Ss correct on both Items 1 and 2 might be selecting the container greatest in width in both cases. Such a centration would result in a false positive assessment. Two 10 ml beakers and one 5 ml graduate were presented, as in Item 2. The procedure and instructions were identical to Item 2, except that the greater quantity, rather than the lesser, was poured into the graduate. Thus, a choice of the widest container in this situation would be incorrect and would suggest that S was not actually a conserver.

Item 3 was provided as a control for the possibility that Ss giving a conservation response to Item 1 and a nonconservation response to Item 2 might be selecting the tallest container in both cases. Such a centration

would attenuate the meaningfulness of the conservation response. Two 10 ml graduates, one of which had been cut to two-thirds the height of the other, and two 10 ml beakers were presented to the child. The procedure and instructions were identical to the first two items, except that the greater quantity was poured from one beaker into the shorter graduate, and the lesser quantity was poured from the beaker into the taller graduate. Selection on the basis of height would result in a nonconservation response.

Item 4 was designed to find whether Ss nonconserving on Item 2 might give a conservation response if E suggested that the S was wrong and demonstrated the result of pouring the liquid back into the original container. Without letting S drink the Coke on Item 2, E said:

> Which one had more before I poured it here (indicating graduate)? See, this one (pointing to beaker with greater quantity) has more Coke in it. This one (pointing to graduate) has less. See (pouring liquid from graduate back into original beaker), it's less. Then this (pointing to beaker with more) has more. Now, I pour it back (pouring lesser quantity into graduate). Now look at them. Now, you take the one with more Coke to drink.
>
> Does it (really) get to be more to drink when I put it in here (pointing to graduate)? How does that happen? (E provided a straw and permitted S to drink the Coke from the container he chose.)

Item 5 was designed to find whether Ss nonconserving on Item 1 might give a conservation response if E suggested that S was wrong and demonstrated the result of pouring the liquid back into the original container. Item 1 was readministered, and if S again gave a nonconservation response, E said:

> Which one had more before I poured it here (indicating 100 ml beaker)? See, this one (pointing to beaker with lesser amount) has less Coke to drink. See, (pouring Coke from 100 ml beaker back into original 10 ml beaker), this is more. Now, I pour it back (pouring from small beaker into larger one). Now look at them. Now you take the one with more Coke to drink.
>
> Does it (really) get to be less to drink when I put it in here (larger beaker)? How does that happen?

If S gave a conservation response to the readministered Item 1, E said:

How could you tell that had more to drink?

Which had more before I poured it here (pointing to larger beaker)?

Does it change when it's poured in here (larger beaker)?

(E allowed S to drink the Coke he chose.)

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. Remembers which beaker had more initially after transformation

   +: Answers memory question correctly

2. Expects constancy

   +: Correctly predicts constant relationship of quantities after transformation with opaque containers (Correct on Prediction Question A and B)

3. Ever conserves without help

   +: Makes conservation response on Q1 or Q2 (Note: Vacillation may occur for an S scored + if he drinks the greater quantity on Q1 or Q2)

4. Believes quantity did not really change

   +: Says transformed quantity did not get to be less/more to drink on all postulations of the question

5. At least conserves with help

   +: a) Conserves on Q1 and Q2
   b) Conserves on Q4 and Q6 after help demonstration (or on one, if only one asked)

6. Consistently conserves

   +: Correct on Q1 and Q2

7. Conserves with certainty

   +: Shows no vacillation, no contradiction in choice of greater quantity; never seems to consider possibility of inconstancy

8. Expects constancy in spite of knowledge of change in level

+: Correctly anticipates change in level on prediction Questions A and B and correctly predicts constancy

In addition, verbalized reasons for choices were scored as follows:

Nonconservation Reasons

1. Irrelevant reason or no reason given
2. Quantity relationship changed "because you poured it"
3. Supernatural cause, e.g., "It's magic."
4. Centration on height, e.g., "This one is up to here, and this one is down to here," "This one is higher."
5. Centration on width, e.g., "This is skinny, and this is fat."

Conservation Reasons

6. Irrelevant reason or no reason given
7. Appearance is irrelevant to quantity, e.g., "It just looks like more/less."
8. Identity, e.g., "It was more/less before you poured it."
9. Empirical reversibility, e.g., "If you poured it back (into original container), it would be more/less."
10. Compensation of relations, e.g., "This one is wider, so it's not so high, and this one is higher so it's skinny."
11. Addition-subtraction principle, e.g., "You didn't add any more Coke in it," "You didn't pour any back in the pitcher (before transformation)."
12. Generalization, e.g., "It stays the same, no matter what you do."

RESULTS

Several lines of evidence suggest that the set of items presented above can be accepted as a description of an invariant developmental sequence of acquisition:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis[2] using Green's (1956) summary statistics was performed

(See Table 28 for reproducibilities and indices of consistency). Table 29 shows the eight perfect scale patterns possible and indicates the number of Ss in each ability group found for each scale type.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 30 indicates that younger children tend to score at the lower scale levels and that older children tend to score at the higher levels. This is reflected in an increase in mean scale scores with increasing age for bright Ss, but for average Ss only from age five to age six (See Table 31). Median ages of scale types shown in Table 29 generally increase as one proceeds from scale level 0 to 7. Table 32 shows that the proportion of Ss passing each scale item increases with age in a regular fashion for bright Ss, but for average Ss, the regularity applies only to the comparison between five and six-year-olds. The small amount of change even for bright Ss from age six to seven suggests that a broader age range is necessary to fully explore the existence of the age-wise progression for this scale. However, analyses of variance indicate that age is a significant factor in performance ($F=7.07, df=2,86, p < .002$ for bright and average groups).

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 33 indicates that of 19 Ss retested after one year, 17 either performed at the same or higher level, and that only 2 Ss scored at a lower level the second year.

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis was performed separately for each ability group to ascertain whether the order of difficulty varies for different IQ groups and whether the same developmental sequence applies. The order of item difficulty is identical for bright, average, and retarded groups,

TABLE 28

RESULTS OF SCALOGRAM ANALYSIS[a] OF CONSERVATION OF CONTINUOUS QUANTITY

Ratios Computed	Bright	Average	Retarded
Reproducibility	.98320	.98157	.98640
Chance Reproducibility	.85966	.85488	.88636
Index of Consistency	.88029	.87300	.88032

[a]Using Green's (1956) summary statistics

TABLE 29

MEDIAN AGE AND FREQUENCY OF SCALE SCORES ON A SCALE OF DEVELOPMENT OF CONSERVATION OF CONTINUOUS QUANTITY FOR BRIGHT, AVERAGE, AND RETARDED SUBJECTS
(N=143)

ale pe	SCALE ITEMS							BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	7	Scale Type	Non-Scale Type	Med. Age Scale Type	Scale Type	Non-Scale Type	Med. Age Scale Type	Scale Type	Non-Scale Type	Med. Age Scale Type
7	+	+	+	+	+	+	+	13	-	88	4	-	82	5	-	115
6	+	+	+	+	+	+	-	7	2	82	4	1	82	4	0	106
5	+	+	+	+	+	-	-	1	0	80	0	0	-	0	0	-
4	+	+	+	+	-	-	-	0	1	-	1	0	91	0	0	-
3	+	+	+	-	-	-	-	0	0	-	2	1	75	2	2	110
2	+	+	-	-	-	-	-	4	1	64	3	2	71	13	2	108
1	+	-	-	-	-	-	-	5	0	77	13	0	91	14	0	98
0	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
								30	4		27	4		38	4	
n	107	67	53	45	42	38	26									
$\bar{n}$	0	40	54	62	65	69	81									

TABLE 30

PERCENTAGE OF SCALE SCORES: LIQUID CONSERVATION
(N=142)

Ability Group	Age Group	0	1	2	3	4	5	6	7	8
Bright	5 (N=16)	00	25	25	12	06	19	12	00	
	6 (N=16)	00	19	06	06	00	06	31	31	
	7 (N=16)	00	12	06	00	06	00	25	50	
Average	5 (N=16)	00	69	12	06	00	00	12	00	
	6 (N=17)	06	24	12	00	12	00	35	12	
	7 (N=16)	00	35	13	13	13	00	00	13	13
Retarded	5 (N=13)	00	46	54	00	00	00	00	00	
	6 (N=16)	00	31	38	19	00	00	06	06	
	7 (N=16)	00	19	25	12	00	00	19	25	

TABLE 31

MEAN LIQUID CONSERVATION SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=142)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	3.25	3.75	3.50	2.12	2.38	2.25	2.38	1.60	2.08
6	5.50	5.88	5.69	4.75	4.11	4.41	3.25	2.38	2.81
7	7.00	5.88	6.44	4.12	2.62	3.38	4.62	4.62	4.62
Mean All Ages	5.25	5.17	5.21	3.67	3.08	3.37	3.42	3.05	3.24

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 32

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED CHILDREN SUCCEEDING ON EACH LIQUID CONSERVATION SCALE ITEM AT THREE AGES[a]

Ability Group	Age Group	Scale Items 1	2	3	4	5	6	7
Bright	5 (N=16)	100	100	27	38	31	12	00
	6 (N=16)	100	69	80	75	69	56	38
	7 (N=16)	100	81	81	81	81	69	56
Average	5 (N=16)	100	40	13[b]	12	12	12	00
	6 (N=17)	94	72	38	59	47	47	27
	7 (N=16)	100	38	56	38	25	25	12
Retarded	5 (N=13)	100	46	08	00	00	00	00
	6 (N=16)	100	56	29	19	12	12	12
	7 (N=16)	100	75	56	50	44	44	25

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b]N=15

TABLE 33

FREQUENCY AND DIRECTION OF CHANGE IN LIQUID CONSERVATION SCALE SCORES AMONG SUBJECTS RETESTED AFTER ONE YEAR (N=19)

Score at First Testing	Score at Second Testing							
	0	1	2	3	4	5	6	7
0		1						
1		2	2	1			2	1
2								1
3							1	1
4		1						1
5								3
6				1			1	
7								

and Table 28 indicates that the set of items is scalable for all three groups.

Level of Performance

While IQ significantly enhances the performance of bright Ss in comparison to average Ss ($F=12.45, df=1,86, p<.0007$), it does not provide average Ss with an advantage over retarded Ss of the same mental age ($F=.17, df=1,83, p<.68$). Table 31 indicates that the mean performance level of bright Ss is higher than that of average Ss at every age level whereas average Ss do not consistently perform at levels higher than retardates. The interaction between mental age and IQ for average and retarded groups approaches significance ($F=2.87, df=1,83, p<.06$); retardates at mental age seven are superior to average Ss at mental age seven, but the reverse is true for mental age six.

Sex Differences

Although bright and average girls show a tendency to perform better than boys at age five and considerably worse than boys at age seven, the sex difference was found not to be statistically significant.

CONSERVATION OF LENGTH

METHOD

Procedures for assessing ability to conserve length were based on some of those described by Piaget (1960). Stimulus materials were cylindrical colored gum straws. The child was seated at a child-sized desk on which the following series of problems involving pairs of sticks (one 4 inches and one $4\frac{1}{4}$ inches) were presented parallel to his line of sight.

Procedure

The first two problems were designed to assess the S's expectancy of constancy in length. The child was asked to predict which of two gum sticks was longer when an invisible position displacement left equal portions of the sticks in view. Colors of pairs and color of longest stick were systematically varied. Also, the prediction procedure controls led for differing tendencies of Ss to center on either near or far ends of sticks.

Prediction Question A: Two unequal sticks (4-inch yellow and $4\frac{1}{4}$-inch green) were presented with ends farthest from child aligned. E said:

> Here are two gum sticks. Show me the bigger and longer one. Now, when I say so, you can pick the bigger one that has more gum to chew to keep. If you don't pick the one with more gum to chew, you won't get any this time, but you'll get another chance to get gum later. Now, before you pick, I put them like this (E placed card over aligned ends and pushed the longer stick into visible alignment with shorter stick. Is one gum stick longer now? Show me the longer one with more gum to chew.
>
> How did you know that had more to chew?
> Which had more to chew before I covered them?

Prediction Question B: Two sticks (4-inch pink and $4\frac{1}{4}$-inch yellow) were presented with ends nearest the child aligned. E said:

> Here are two more gum sticks. Show me the bigger one. Now, when I say so, you can pick the longer one that has more gum to chew. If you don't pick the one with more to chew, you won't get any this time. You'll get another chance to get gum later. Now, before you

pick, I put them like this (E placed card over aligned ends and pushed the protruding longer stick into alignment with shorter stick). Is one gum stick longer now? Show me the longer one with more gum to chew.

How did you know that had more to chew?
Which one had more to chew before I covered them?

Items 1 and 3 are the conservation test items which parallel Prediction Questions A and B, controlling for centration tendencies by moving the shorter stick away from S in Item 1 and by moving the shorter stick toward S in item 3. Items 2 and 4 were given only to Ss who did not conserve on Items 1 or 3 in order to provide an opportunity for the child to recognize the contradiction in his selections and to investigate the degree to which the S believed the transformation really changed the quantity.

Item 1 was designed to explore S's ability to conserve when a shorter stick was displaced so that the end nearest S extended beyond the longer one. Placing two gum sticks (4-inch orange and $4\frac{1}{4}$-inch purple) on the table, with the ends farthest from the child aligned, E said:

> Here are two gum sticks. One is bigger than the other. One is longer. You don't need to show me, but can you see that one is bigger than the other? When I say so, you can pick the bigger one to keep or to chew. If you don't pick the biggest one with more gum to chew, you won't get gum this time. You'll get another chance to get gum later. Now, before you pick, I put them like this (E moved shorter orange stick toward child so that it extended about $\frac{1}{2}$-inch beyond the other stick). Now, look at them. If you can show me the one with more gum to chew, you may have it. How could you tell it was bigger?

If S said, "I looked at it," "I saw this was biggest," or similar ambiguous response which could refer to a remembrance of which was bigger prior to the transformation, E asked: "When did you look/see it?" If S said, "I measured," or demonstrates by aligning the sticks, E replaced the sticks in the transformation position and asked, "But how can you tell when they're like this?" Finally, the memory question was asked: "Which had more to chew before I moved them like this?"

Item 2 was administered only to Ss who nonconserved on Item 1 in order to challenge their response and explore beliefs about the reality and

causality of the phenomenon. E said:

> You told me this was the biggest one (pointing to shorter orange). (E moved longer purple stick toward S so that its end nearest S extended about $\frac{1}{2}$-inch beyond the orange one.) Now show me the big one.

If S picked the longer purple stick, Item 2a was administered:

> Item 2a: (E replaced sticks in original position, with ends farthest from child aligned.) Before, you said this (E moved orange toward S as in Item 1 so it extended beyond the purple) was biggest. Now, (E moved purple toward S as in Item 2 so it extended beyond orange) you say this (pointing to purple) is bigger. Does it really change? Does this get to be more gum to chew? How does that happen?

Item 3 was designed to explore S's ability to conserve when a shorter stick was displaced so that the end furthest from S extended beyond the longer one. Placing two gum sticks (4-inch purple and $4\frac{1}{4}$-inch pink) on the table, with the ends nearest S aligned, E said:

> Here are two more sticks of gum. One is bigger than the other. One is longer. You don't need to show me, but can you see that one is bigger than the other? When I say so, you can pick the bigger one to keep or to chew. If you don't pick the biggest one with more gum to chew, you won't get gum this time. You'll get another chance to get gum later. Now, before you pick, I put them like this (E moved the purple stick away from S so that its far end extended about $\frac{1}{2}$-inch beyond the pink stick). Now, look at them. If you can show me the biggest one, you may have it. How could you tell it was bigger?

If S realigned the sticks or gave an ambiguous response possibly referring to a memory of the pre-transformation state, E probed as described in Item 1, above. Finally, the memory question was asked: "Which had more to chew before I moved them like this?"

Item 4 was administered only to Ss who nonconserved on Item 3 in order to challenge their response and explore beliefs about the reality and causality of the phenomenon. This procedure was identical to that of Item 2, except that it explores beliefs about the transformation resulting from moving the shorter stick away from, instead of toward, the child.

Item 5 was intended to investigate S's ability to conserve in the

context of a somewhat more difficult situation where the longer gum stick is bent in an arc so that its end points describe a shorter straight line than that of the shorter stick. Placing two gum sticks (4-inch pink, $4\frac{1}{4}$-inch orange) on the table with ends aligned in accordance with any centration expressed on previous items, E said:

> See, one is bigger, one is longer? When I say so, you can pick the bigger one with more gum to chew. If you don't pick the biggest one, you won't get gum this time. You'll get another chance to get gum later. Now, before you pick, I put them like this. (E bent longer orange stick so that a straight line drawn between the end points would be about 3-3/4-inches long; end alignment was maintained.) Now, look at them. If you can show me the biggest one with more gum to chew, you may have it.
>
> Which was bigger before I bent it? What happened?

Nonconservers were further investigated in the following manner.

> (E straightened the longer orange stick and bent the shorter pink one.) Now show me the big one. Does it (really) change when I bend it? Why (not)?

Item 6 was intended to elicit measuring behavior as well as provide a useful response latency measurement. Two gum sticks (4-inches and $4\frac{1}{4}$-inches, of the same color) were presented in a random, non-parallel arrangement. E said, "Show me the bigger one." If S did not measure, E said, "Show me how you can tell which is bigger. How can you make sure?" If S still did not measure, E said, "If I thought this (child's non-choice) is the bigger one, how could you show me it's not?" If S still did not measure, E said, "Can you measure?" For Ss still not measuring, E said, "Put them together so you can really be sure." Measuring behavior was carefully noted.

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. Discriminates greater length when two sticks are aligned

   +: a. Points to longer sticks when aligned on Prediction Questions

b. Chooses longer stick on Q6 with or without aligning

2. Remembers which stick was longer before change in array

+: Correct on the majority of memory questions (Which had more before?)

3. Expects constancy of length

+: Predicts correctly that stick shown to be longer when in alignment is still longer when card covers non-aligned ends on both presentations

Note: Code "c" to indicate specific spontaneous reference to covered ends.

4. Conserves length in disalignment

+: Selects longer stick when shorter is advanced away and when advanced toward (takes longer on Q1, Q2, and Q3c)

5. Conserves length in deformation

+: Selects longer stick when it is bent (takes longer on Q5)

6. Believes quantity of gum does not really change

+: Says quantity did not really get to be more gum to chew, did not really change, on all postulations of question

7. Conserves length with certainty

+: Shows no vacillation or uncertainty in selecting longer stick; does not remeasure to check choice (remeasuring to demonstrate or prove to E which is longest does not warrant a score of "-" here).

In addition, verbal reasons for conservation were scored as follows:

1. Irrelevant reason or no reason given, e.g., "It's more," "It's longer," "It didn't change."

2. No verbalization, but S realigns to demonstrate.

3. Position, shape, or card cover are irrelevant to quantity, e.g., "It just looks like it's bigger," "That doesn't matter; it's still bigger," "You just moved/bent it," "You can move it and measure it."

4. Identity, e.g., "It was bigger before," "I remembered how it was at first," "I saw it before," "When it was up there, it was bigger," "It's made bigger."

5. Empirical reversibility, e.g., "If you put it here, it would come to here (indicating end differential)," "You could unbend it."
6. Compensation of relations, e.g., "It's bigger up here but smaller down there."
7. Addition-subtraction principle, e.g., "You can't make that longer unless you get some more gum," "It can't change unless you break off some."
8. Generalization, e.g., "No matter what you do, it stays the same size," "This is always biggest," "It wouldn't change; it's still smaller," "It would still be the same."

Results

A scalogram analysis (see Table 39) using Green's (1956) summary statistics indicated that the set of seven items presented above forms a Guttman scale. Table 40 presents the frequency of Ss passing and failing each scale item and frequency of bright, average, and retarded Ss at each scale level.

Developmental Sequence

Although the need for a broader age-range attenuates a firm conclusion concerning sequence of acquisition, several lines of evidence suggest that the scale may be tentatively viewed as describing a developmental sequence of acquisition.

1. The items are ordered in terms of increasing difficulty. Table 39 shows reproducibilities and indices of consistency which indicate that the seven items are ordered in terms of their difficulty.

2. A general increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 41 shows a clear age increase in mean level of performance from age five to age six, but either no change or a decrease from age six to age seven. The age effect is

TABLE 39

RESULTS OF SCALOGRAM ANALYSIS[a] OF LENGTH CONSERVATION ITEMS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.98607	.98498	.97778
Chance Reproducibility	.91322	.87044	.88563
Index of Consistency	.83947	.88406	.80571

TABLE 40

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT EACH LENGTH CONSERVATION SCALE LEVEL
(N=124)

	ITEMS							BRIGHT			AVERAGE			RETARDED		
Scale Types	1	2	3	4	5	6	7	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
7	+	+	+	+	+	+	+	28	0	85	14	0	80	14	0	108
6	+	+	+	+	+	+	-	1	0	78	2	-	88	2	0	113
5	+	+	+	+	+	-	-	-	3	-	-	1	-	2	3	120
4	+	+	+	+	-	-	-	3	0	68	3	-	75	6	2	102
3	+	+	+	-	-	-	-	1	1	61	7	2	95	7	1	95
2	+	+	-	-	-	-	-	4	0	68	9	-	68	6	1	95
1	+	-	-	-	-	-	-	-	-	-	-	-	-	1	-	115
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
								37	4		35	3		38	7	
n	124	121	98	83	69	70	56									
$\bar{n}$	0	3	26	41	55	54	68									

TABLE 41

MEAN LENGTH CONSERVATION SCALE SCORES FOR BRIGHT, AVERAGE AND RETARDED CHILDREN AT THREE AGES[a]

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.62	4.50	4.56	3.89	5.12	4.47	3.38	4.80	3.92
6	7.00	6.62	6.81	5.62	5.67	5.65	4.38	4.25	4.31
7	7.00	6.12	6.56	4.88	4.25	4.56	6.00	4.75	5.38
Mean All Ages	6.21	5.75	5.98	4.76	5.04	4.90	4.58	4.57	4.54

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

significant for bright and average groups ($F=8.12$, $df=2, 86$, $p<.0006$). These age trends are also reflected in Table 42 which shows percentage of scale scores at each age level and in Table 43 which shows the percentage of Ss succeeding on each scale item. The need for a sample of younger Ss in order to assess the scale's age relatedness results from the fact that no S fails the easiest scale item, and only three Ss fail the second scale item. Broadening the sample to older Ss than those studied here (especially with regard to average Ss) would clarify whether the scale is not age-related in terms of progression or whether progress occurs so slowly and with such oscillation during the years six and seven that these years should be viewed as unitary. It may be that the regularity in age change is visible when broader age-ranges are grouped.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 44 presents the frequency distribution of scale scores at first testing and again one year later. Eight of the nineteen Ss remained at the same level the second year as the first year. Eight Ss performed at a higher level the second year, and three Ss appear to have regressed. While more longitudinal data is needed to ascertain whether the sequence described by the scale can be viewed as one which individuals must pass through in an invariant fashion, it seems a promising direction of further inquiry inasmuch as it accounts for performance change for most Ss.

Effect of IQ on Performance

IQ is not as potent a factor as mental age with regard to level of performance on this length conservation task. Bright children perform at significantly higher levels than average children ($F=9.75$, $df=1, 86$, $p<.0025$), especially at ages six and seven. However, the difference between average and retarded Ss of the same mental age is not significant.

TABLE 42

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT THREE AGES[a] SCORING AT EIGHT LENGTH CONSERVATION SCALE LEVELS (N=143)

Ability Group	Age	Items 0	1	2	3	4	5	6	7
Bright	5 (N=16)	00	00	19	12	25	13	00	31
	6 (N=16)	00	00	00	00	00	06	06	88
	7 (N=16)	00	00	06	00	00	06	00	88
Average	5 (N=17)	00	00	41	00	12	06	00	41
	6 (N=17)	00	00	06	18	12	00	00	64
	7 (N=16)	00	00	12	38	06	00	13	31
Retarded	5 (N=13)	00	00	23	15	30	15	08	08
	6 (N=16)	00	06	06	38	12	07	00	31
	7 (N=16)	00	00	19	00	12	13	06	50

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 43

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT THREE AGES[a] SUCCEEDING ON EACH LENGTH CONSERVATION SCALE ITEM (N=143)

Ability Group	Age	1	2	3	4	5	6	7
Bright	5 (N=16)	100	100	67[b]	69	31	11[c]	31
	6 (N=16)	100	100	94	100	100	100	88
	7 (N=16)	100	100	94	94	88	94	88
Average	5 (N=17)	100	100	60	59	41	22	41
	6 (N=17)	100	94	84	71	76	69	84
	7 (N=16)	100	100	81	56	44	44	31
Retarded	5 (N=13)	100	100	76	54	30	23	08
	6 (N=16)	100	94	81	50	31	44	31
	7 (N=16)	100	94	81	75	75	62	50

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=3

[c] N=9

TABLE 44

FREQUENCY OF LENGTH CONSERVATION SCALE SCORES OBTAINED BY SUBJECTS RETESTED AFTER ONE YEAR (N=19)

First Testing Scale Score	Second Testing Scale Score							
	0	1	2	3	4	5	6	7
0								
1								
2			1	1				3
3								
4							1	2
5								1
6								
7				2	1			7

Thus, when mental age is controlled, a higher IQ is no advantage in this developmental task, at the age levels studied.

Effect of Sex on Performance

No statistically significant sex differences appeared in performance on this task, although for bright Ss particularly, girls scored at lower levels consistently, and the difference between boys and girls widens with increasing age.

CONSTANCY OF GENERIC IDENTITY

METHOD

The procedures used to investigate children's beliefs about the constancy of generic identity were derived from pilot work by Kohlberg (1963) and from a study by DeVries (1969). Plasticized black and white glossy pictures of the unmasked live black cat were retouched to either remove or accentuate whiskers in the prints for test items 2, 3, and 4. Five pictures showed the animal as follows:

1. Side view of cat with whiskers accentuated, in standing position
2. Cat with whiskers accentuated, in crouching position
3. Side view of cat (same as in 1) with whiskers missing
4. Cat with whiskers missing, in crouching position (same as in 2)
5. Side view of cat wearing dog mask

Procedure

Item 1 was designed to explore the child's belief about whether a desire for identity change would be sufficient to bring about a real change in identity. E presented Picture 1 and asked:

> If this cat really wants to be a dog, can he?
>
> (If S says no): Why not?
>
> (If S says yes): Would he be a real dog? Why (not)?

Item 2 explored the child's belief about whether one behavioral change would be sufficient to bring about a real change in identity. E presented Picture 2 alongside Picture 1 and asked:

> If this cat (pointing to Picture 1) barks like a dog (pointing to Picture 2), what would he be (pointing to Picture 1)? Would he be a cat or a dog?
>
> (If S says dog): Would he be a real dog then? Why is that?

Item 3 explored the child's belief about whether one change in a physical characteristic would be sufficient to bring about a real change in identity. E presented Picture 3 beside Picture 1 and asked:

If this cat (pointing to Picture 1) had his whiskers cut off like a dog does (pointing to Picture 3), what would he (pointing to Picture 1) be? Would he be a cat or a dog?

(If S says dog): Would he be a real dog then? Why is that?

Item 4 focussed on the child's belief about whether the combination of one behavioral and one physical change would be sufficient to result in identity change. E presented Picture 4 beside Picture 1 and asked:

What if this cat (pointing to Picture 1) has his whiskers cut off and barks like a dog (pointing to Picture 4)? What would he be? Would he be a cat or a dog?

(If S says dog): Would he be a real dog then? Why is that?

Item 5 explored the child's belief about whether two changes in physical appearance would be sufficient to bring about a real change in identity. E presented Picture 5 alongside Picture 1 and said:

This cat (pointing to Picture 1) meows--it doesn't bark--but if he has his whiskers cut off and his head is like a dog (pointing to Picture 5) what would he be? Would he be a cat or dog?

(If S says dog): Would he be a real dog then? Why is that?

Item 6 was designed to assess the child's belief about whether the two changes in physical characteristics plus the change in behavior would be sufficient to bring about identity change. The pictures used are the same as for Item 5. E said:

What if this cat (pointing to Picture 1) has his whiskers cut off, his head like a dog, and barks like a dog? What would he be? Would he be a cat or dog?

(If S says dog): Would he be a real dog then? Why is that?

Item 7 was a limits-testing question included to explore the extent to which the child believed that change in identity does or could happen in the real world. E said:

Could that really happen? Could a real cat change into a real dog? Why (not)?

(If no response or S said he didn't know): What if a real cat _____ (E described change or changes to which S had admitted a change

in identity)? Would a real cat be a real dog then? Why (not)?

It should be noted that E did as little suggestive questioning as possible beyond the stimulus question. The question, "Would he be a cat or dog?" was given only when S did not respond to the question, "What would he be?"

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. At least resists suggestion that cat will become dog (entire interview)

   a. Says he doesn't want it to (be a dog, bark, etc.)
   b. Says animal is cat on any question, or is not real dog or not sure
   c. Says he doesn't look like a dog
   d. Says one picture is cat, and one is dog
   e. Says is neither cat nor dog; may suggest another identity (includes "pretend")
   f. Suggests counter cat-attributes or lack of some dog-attribute
   g. Contradicts specific suggestion in question; e.g.,
      Q1: He wants to be a cat
      Q2: People don't cut his whiskers off
      Q3: Cats don't bark
   h. Says animal is both cat and dog, or partly cat and partly dog
   i. Says he's nothing
   j. Says don't know what he is, not sure, maybe
   k. Gives moral reason
   l. Simply "cannot change"
   m. Magic, "ghosts," etc.
   n. States constancy principle
   o. Irrelevant statement
   p. Everybody would know. . .

2. Says cat will not change to new identity at some point (or other non-cat identity)

   Plus is given on this item if a subject says the cat can't be a dog on any Questions. (This allows differentiation between children who fail only half of Item 4 or 5; those who say a cat can't be a dog on Question 2 and 3, or on Question 4 or 5, will thus receive a higher scale score than those who say the cat can be a dog on both questions in the item.)

3. Says cat cannot be a dog if it wants to

   a. Says no on Q1
   b. Says yes, but says can't be real dog on Q1

4. Says cat will not be a dog if whiskers are cut off like a dog, or if he barks like a dog.

   a. Says animal is cat on both Q2 and Q3
   b. Says animal is dog, but says is not real dog on Q2 and Q3

5. Says a change from a cat into a dog cannot really happen.

6. Says cat will not be a dog if whiskers are cut off and he barks like a dog, or if he meows but has his whiskers cut off and the head is like a dog.

   a. Says animal is cat on both Q4 and Q5
   b. Says animal is dog, but not real dog on Q4 and Q5

7. Says cat will not be a dog if his whiskers are cut off, his head is like a dog, and he barks like a dog.

   a. Says animal is cat on Q6
   b. Says animal is dog, but not real dog

8. Says animal is still a cat throughout the interview, with stability.

   a. Never says animal would be a dog, or always says it would not be a real dog.

      (This item allows differentiation between subjects whose conservation responses never waver and those who succeed on all items but who give a nonconservation response at some point and then change to a conservation response.)

In addition, verbal reasons were scored as follows:

1. No reason given. A cat is believed to change into a dog if it looks or acts like a dog.
2. The possibility of change is resisted and may be partially denied, but conclusion is an admission of change.
3. Appearance is irrelevant to identity, e.g., "It just looks like" a dog.
4. Additional attributes are mentioned to counter suggested changes, e.g., "He wants to be a cat," "Cats have longer tails."
5. Absolutistic denial of change, e.g., "God made it that way," "It has to stay a cat."
6. Identity constancy, e.g., "It started out a cat, and it has to stay a cat."

Results

A scalogram analysis (See Table 45) using Green's (1956) summary

statistics was performed which indicated that the set of eight dichotomous items presented above forms a Guttman scale. Table 46 presents the frequency of Ss passing and failing each scale item and the frequency of bright, average, and retarded Ss at each scale level. Several lines of evidence suggest that this scale does describe a developmental sequence of acquisition.

1. The items are ordered in terms of increasing difficulty. Table 45 shows reproducibilities and indices of consistency which indicate that the eight items are ordered from least to most difficult and that subjects passing a particular scale item may be expected to pass all easier items. Similarly, subjects failing an item may be expected to fail all harder items.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 47 shows that younger Ss generally tend to score at lower scale levels while older Ss tend to score at higher levels. Table 48 shows an age-wise increase in mean performance at each age level for bright children, but an increase for average children from only age five to age six. The analysis of variance indicated a statistically significant age effect ($F=3.17$, $df=2, 86$, $p<.05$), but the interaction of sex and IQ with age attenuates this finding ($F=3.22$, $df=2, 86$, $p<.045$). Nevertheless, the regularity of age changes, particularly for bright Ss, in percentage of Ss succeeding on scale items (See Table 49) still suggests that an age-developmental sequence described by the scale may exist. Again, the possibility appears that average children may be on a developmental plateau at ages six and seven and that a broader age-range is needed in order to make the age-developmental trend visible.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Two Ss remained at the same level of

TABLE 45

RESULTS OF SCALOGRAM ANALYSIS[a] OF GENERIC IDENTITY ITEMS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.96875	.969388	.98296
Chance Reproducibility	.89849	.908527	.87506
Index of Consistency	.69214	.66534	.86361

[a]Using Green's summary statistics

TABLE 46

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT EACH GENERIC IDENTITY SCALE LEVEL (N=141)

	SCALE ITEMS								BRIGHT			AVERAGE			RETARDED		
Scale Type	1	2	3	4	5	6	7	8	Scale Type	Non-Scale Type	Med. Age Scale Type	Scale Type	Non-Scale Type	Med. Age Scale Type	Scale Type	Non-Scale Type	Med. Age Scale Type
8	+	+	+	+	+	+	+	+	17	-	87	7	-	78	14	-	112
7	+	+	+	+	+	+	+	-	2	2	84	0	1	-	0	0	-
6	+	+	+	+	+	+	-	-	3	3	83	1	1	66	2	2	116
5	+	+	+	+	+	-	-	-	5	1	71	4	2	81	2	0	112
4	+	+	+	+	-	-	-	-	2	6	72	7	7	78	3	3	114
3	+	+	+	-	-	-	-	-	7	0	78	16	1	81	15	1	95
2	+	+	-	-	-	-	-	-	0	0	-	0	0	-	2	0	108
1	+	-	-	-	-	-	-	-	0	0	-	2	0	82	0	0	-
0	-	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
									36	12		37	12		38	6	
n	141	139	135	81	77	53	52	41									
$\bar{n}$	0	2	6	60	64	88	89	100									

TABLE 47

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS AT THREE AGES[a] SCORING AT NINE GENERIC IDENTITY SCALE LEVELS (N=142)

Ability Group	Age	0	1	2	3	4	5	6	7	8
Bright	5 (N=16)	00	00	00	19	25	25	06	06	19
	6 (N=16)	00	00	00	12	19	06	25	06	31
	7 (N=16)	00	00	00	12	06	06	06	12	56
Average	5 (N=17)	00	00	00	47	41	00	06	00	06
	6 (N=17)	00	12	00	12	24	24	00	06	24
	7 (N=16)	00	00	00	44	25	12	06	00	12
Retarded	5 (N=13)	00	00	15	46	23	00	00	00	15
	6 (N=16)	00	00	00	50	00	00	12	00	38
	7 (N=15)	00	00	00	13	20	13	13	00	40

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 48

MEAN GENERIC IDENTITY SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=142)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.38	5.88	5.12	3.89	3.88	3.88	3.50	4.40	3.85
6	6.12	5.62	5.88	4.25	5.44	4.88	4.00	6.50	5.25
7	7.88	5.60	6.69	4.12	4.50	4.31	6.25	5.43	5.87
Mean All Ages	6.12	5.67	5.90	4.08	4.64	4.36	4.58	5.60	5.05

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 49

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED SUBJECTS AT THREE AGES[a] SUCCEEDING ON EACH GENERIC IDENTITY SCALE ITEM (N=143)

Ability Group	Age	1	2	3	4	5	6	7	8
Bright	5 (N=16)	100	100	100	62	62	38	25	25
	6 (N=16)	100	100	100	75	81	44	56	31
	7 (N=16)	100	100	100	81	81	75	69	62
Average	5 (N=17)	100	100	94	18	44	18	12	6
	6 (N=17)	100	88	88	71	47	35	29	29
	7 (N=16)	100	100	100	50	31	19	19	12
Retarded	5 (N=13)	100	100	76	23	23	15	30	15
	6 (N=16)	100	100	100	50	50	44	44	38
	7 (N=15)	100	100	100	80	67	46	53	40

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

performance, 11 progressed, and 6 appear to have regressed. However, 3 of the Ss appearing to have regressed moved from a non-scale Type 4 to a Scale Type 3, so these Ss probably should not be viewed as really regressing. The scale accounts for change in performance of most of the retested Ss.

Effect of IQ on Performance

Bright Ss perform at significantly higher levels than average children of the same chronological age ($F=18.77$, $df=1, 86$, $p < .0001$), even when the sex-age-IQ interaction effect is removed. The higher level of performance of retarded Ss in comparison to average Ss of the same mental age approaches significance ($F=2.78$, $df=1, 82$, $p < .099$). This suggests that not only is higher IQ no advantage in the development of generic identity, but older chronological age is a facilitating factor in this development.

Effect of Sex on Performance

No significant sex differences in performance appeared, but the sex effect approached significance for average and retarded Ss ($F=3.43$, $df=1, 82$, $p < .068$), and the interaction of age with sex approached significance ($F=2.39$, $df=2, 82$, $p < .098$). There is a general tendency for girls to perform better than boys at younger ages here, but less well than boys at age seven (mental age seven in the case of the retardates). For bright and average Ss, the sex-age-IQ interaction ($F=2.88$, $df=2, 86$, $p < .06$) approaches significance, but this is due to the tendency of sex to interact with the primary effect of age which remains a significant factor in performance even after removing all interaction and other main effects ($F=3.13$, $df=2, 86$, $p < .05$).

TABLE 50

FREQUENCY OF GENERIC IDENTITY SCALE SCORES OBTAINED BY SUBJECTS RETESTED AFTER ONE YEAR
(N=19)

First Testing Scale Score	Second Testing Scale Score								
	0	1	2	3	4	5	6	7	8
0									
1					1				
2									
3		1			1				2
4				3		2	1		2
5						1	1		1
6									
7									
8					2				1

SIBLING EGOCENTRISM

METHOD

The method used in assessing the ability to take a non-egocentric view with regard to siblings was almost parallel to that used by Piaget (1928).

Procedure

E asked the following questions if S was a boy:

1. How many brothers do you have? What are their names?
2. How many brothers does _____ (E used name of S's brother) have?

If S had no brothers, E asked the same questions about sisters. Finally, E ascertained whether S had a sibling younger than himself. A parallel form was used for girls, substituting "sisters" for "brothers."

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. Knows brother/sister are terms restricted to family members

   +: Names no non-family members as siblings (pets may be included)

2. Understands brother/sister as relational to self

   +: Does not name self when asked number or names of siblings; sib belongs to him

   Note: Some Ss seem to interpret "How many brothers/sisters do you have?" as "How many _____ are in your family?" They go on to differentiate self from siblings in such a way as to indicate that they distinguish sibling terms from terms "girls/boys."

3. Understands brother/sister as relational to sibling

   +: Sees self as belonging to sibling, e.g., "He has me for a brother," "I'm his brother," but may say "No" to whether _____ has any brothers/sisters, or gives contradictory responses, e.g., includes self as own brother and as brother's brother.

4. Understands brother/sister as totally reciprocal terms

   +: Does not include self as own brother/sister
   Says sibling has sibling/s (Says sib has same number of sibs as he does himself)
   Includes self as sibling's sibling

If response was contradictory and contained any indication of non-reciprocity, it was scored "+" on Item 3 and "-" on Item 4.

Results

A scalogram analysis using Green's (1956) summary statistics was performed (See Table 51 for reproducibilities and indices of consistency) which indicated that the set of four items presented above forms a Guttman scale. Table 52 shows the median age and frequency of bright, average, and retarded Ss at each scale level.

Developmental Sequentiality of Acquisition

The findings do not strongly support a conclusion that the Guttman Scale describes a developmental sequence of acquisition. However, neither do they suggest a negative conclusion, but rather that a broader age-range needs to be sampled. The evidence on the critical points necessary to consider with regard to developmental sequentiality is as follows:

1. Order of difficulty: The items are ordered in terms of increasing difficulty, as indicated by the scalogram analysis results in Table 51.

2. Age-wise progression along the scale: Mean scale scores for bright, average, and retarded Ss shown in Table 53 indicate no regular increase in performance with increased chronological age, and the analysis of variance showed no statistically significant age effect for bright and average groups. Table 54 shows little difference in the age distribution of scale scores, and Table 55 similarly shows little difference in the percentage of Ss succeeding on scale items at different age levels. However, it is clear that development of relativity of perspective with regard to sibling relationships is generally completed later than age seven, especially by average children. Therefore, the age similarity in performance may simply reflect a period of no developmental change. Thus, a broader age-range needs to be sampled to determine whether an age-wise progression does

TABLE 51

RESULTS OF SCALOGRAM ANALYSIS OF SIBLING EGOCENTRISM ITEMS

Ratios Computed[a]	Bright (N=46)	Average (N=45)	Retarded (N=39)
Reproducibility	.99457	.98889	.96154
Chance Reproducibility	.93762	.94077	.90533
Index of Consistency	.91295	.81242	.59374

[a]Using Green's (1956) summary statistics

TABLE 52

MEDIAN AGE AND FREQUENCY OF SUBJECTS AT EACH SIBLING EGOCENTRICISM SCALE LEVEL
(N=130)

	SCALE ITEMS				BRIGHT			AVERAGE			RETARDED		
Scale Type	1	2	3	4	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
4	+	+	+	+	29	0	80	9	0	79	13	0	108
3	+	+	+	-	2	1	80	12	1	68	2	5	101
2	+	+	-	-	12	0	75	16	1	84	12	1	105
1	+	-	-	-	2	0	76	4	0	81	6	0	107
0	-	-	-	-	0	0	-	2	0	64	0	0	-
					45	1		43	2		33	6	
n	128	107	75	57									
$\bar{n}$	2	23	55	73									

TABLE 53

MEAN SIBLING EGOCENTRISM SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=140)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	2.88	3.57	3.20	2.33	2.43	2.38	2.57	2.60	2.58
6	3.38	3.38	3.38	2.75	2.11	2.41	2.38	2.71	2.54
7	2.88	3.43	3.13	2.88	2.28	2.60	2.43	2.88	2.67
Mean All Ages	3.04	3.44	3.54	2.64	2.26	2.46	2.45	2.73	2.58

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 54

PERCENTAGE OF SIBLING EGOCENTRISM SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=136)

Ability Group	Age	0	1	2	3	4
Bright	5 (N=15)	00	07	26	07	60
	6 (N=16)	00	00	25	12	63
	7 (N=15)	00	07	33	00	60
Average	5 (N=16)	12	00	31	50	07
	6 (N=17)	00	24	35	18	23
	7 (N=15)	00	06	53	13	28
Retarded	5 (N=12)	00	17	33	25	25
	6 (N=15)	00	20	40	07	33
	7 (N=15)	00	20	26	20	34

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 55

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN SUCCEEDING ON EACH SIBLING EGOCENTRISM SCALE ITEM AT THREE AGES[a]

			Items			
Ability Group	Age		1	2	3	4
Bright	5	(N=15)	100	86	66	66
	6	(N=16)	100	100	75	62
	7	(N=15)	100	93	60	60
Average	5	(N=16)	88	88	60[b]	06[b]
	6	(N=17)	100	76	46[b]	26[b]
	7	(N=15)	100	80	46	33
Retarded	5	(N=12)	100	63[c]	63[c]	45[c]
	6	(N=15)	100	73	50[d]	33
	7	(N=15)	100	60	53	53

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=15

[c] N=11

[d] N=14

occur.

3. Longitudinal progression: Table 56 shows scale scores of Ss retested after one year. Of the 18 Ss (one was unscorable on the second test), 10 Ss scored at the same level on both testings, 3 Ss scored at higher levels on the second testing, and 4 Ss scored at lower levels on the second testing. Again, the findings are equivocal regarding age progression.

Effect of IQ on Performance

Table 53 shows a higher level of performance for bright Ss at every age than for average Ss. This difference is statistically significant ($F=12.84$, $df=1, 82$, $p < .0006$). However, the comparison between average and retarded groups where mental age is controlled, shows little difference in performance, and this difference is not statistically significant.

Effect of Sex on Performance

Although bright and retarded girls tended to perform slightly better than boys in their IQ groups, average girls tended to perform slightly less well than average boys. No sex differences were statistically significant.

Reciprocity with Like-Sex and Unlike-Sex Siblings

Table 57 shows the percentage of bright, average, and retarded children who understand the reciprocity of sibling relationship with unlike-sex siblings and with like-sex siblings. For all IQ groups, it appears somewhat easier to understand the reciprocity when it pertains to a sibling of the opposite sex. However, since most Ss did not have siblings of both sexes, these percentages do not provide a direct comparison for individual children. Table 58 shows the results when only the 44 Ss having both like-sex and unlike-sex siblings are considered. Thirty-one Ss are consistent in their understanding of reciprocity for like-sex and unlike-sex siblings; they

TABLE 56

FREQUENCY OF SIBLING EGOCENTRISM SCALE SCORE OBTAINED BY SUBJECTS RETESTED AFTER ONE YEAR (N=18)

First Testing Scale Score	Second Testing Scale Sc				
	0	1	2	3	4
0		1			
1					
2		1	5		1
3		1	2	2	1
4					4

TABLE 57

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN WHO UNDERSTAND RECIPROCITY OF SIBLING RELATIONSHIP FOR UNLIKE-SEX AND LIKE-SEX SIBLINGS, BY AGE[a] AND SEX
PERCENTAGE RECIPROCAL WHEN Q RE:

		UNLIKE-SEX SIBLINGS			LIKE-SEX SIBLINGS		
Ability Group	Age	Boys	Girls	All	Boys	Girls	All
Bright	5 (N=16)	00	67	67	50	80	61
	6 (N=16)	86	80	83	50	67	58
	7 (N=16)	67	60	63	40	100	67
	All Ages	76	69	73	47	80	62
Average	5 (N=17)	40	00	22	00	00	00
	6 (N=17)	75	00	38	14	67	30
	7 (N=16)	75	60	67	50	20	36
	All Ages	61	23	42	20	27	23
Retarded	5 (N=13)	67	50	57	40	40	40
	6 (N=16)	40	50	45	43	50	46
	7 (N=16)	60	75	67	40	71	58
	All Ages	53	57	56	41	55	49

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 58

RELATIVE DIFFICULTY OF RECIPROCITY RELATION FOR LIKE-SEX AND UNLIKE-SEX SIBLINGS: FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED CHILDREN HAVING SIBLINGS OF BOTH SEXES
(N=44)

		Like-Sex Sibling	
Unlike-Sex Sibling		Unreciprocal (-)	Reciprocal (+)
Bright	-	3	0
	+	5	3
Average	-	4	0
	+	6	2
Retarded	-	8	1
	+	1	11

are either reciprocal for both or unreciprocal for both. Of the remaining 13 Ss who are reciprocal for one and unreciprocal for the other, only one retarded S was reciprocal for the like-sex sibling and unreciprocal for the unlike-sex sibling. Thus, it does appear that reciprocity with regard to a sibling of the opposite sex is an easier cognitive task than for a sibling of the same sex.

CONCEPTS OF MAGIC

METHOD

The procedure used to investigate children's notions about magical causality was developed by Kohlberg (1966). The task utilizes a red velvet magician's change bag whose handle can be locked so that the double lining cannot be reversed.

Procedure

The first part of the interview focuses upon the child's spontaneous reactions to the "transformation" of a small toy cat (about 2 inches tall) into a hollow, flexible rubber bird (about 6 inches tall). The child's reactions were observed, and E's further questions were designed to clarify the child's beliefs concerning the reality and causality of the change. E showed the bag (which had the bird concealed in the hidden compartment) to the child and said):

> Now this is a special bag that makes funny things happen. See this cat? Take the cat and put it in the bag. Go ahead. Put it in the bag. What do you think will happen to the cat? Abracadabra Allakazam (making circular motions over the bag)! (E turned the handle of the bag surreptitiously so that the inner lining covered the cat and revealed the bird.) Look what happened (E took out bird). Look at that. Where is the cat? What happened to the cat? (E turned the bag inside out.) I don't see it.
>
> Did the cat really turn into a bird?
> Is it still the same? Is the cat inside the bird?
> How did it happen? What made it turn into a bird?

The second transformation of the bird back into the cat was primarily designed to provide E the opportunity to palm the small cat and lock the handle in preparation for the last part of the interview. However, this did provide further opportunity to observe the child's reactions, and E's questions were designed to explore the child's willingness to accept the suggestion of a magical cause. E said:

> Let's put the bird back in the bag. Abacadabra Allakazam? (E turns the handle surreptitiously and takes out the cat.)
>
> How did it happen? How did it work?

Was it magic?
(If S said it was magic): Was it pretend or real magic?

The final part of the interview was designed to obtain behavioral evidence with regard to the child's belief about the cause. E said:

> Now I'll put the cat back in the bag (E put hand with cat in the bag, withdrew it without leaving cat in bag, and kept it concealed.) Abacadabra Allakazam (E motioned in circular fashion over bag, turned handle and locked it). There, it's the bird again. Now, can you do it? Change the bird back into a cat. Go ahead and try.
>
> (If S did not try): Make it change into a bird, and I'll give you some candy.

E noted the procedure used by the child. If S did not say, "Abacadabra Allakazam," E asked, "Why didn't you go 'Abacadabra' like I did?" All children were asked "Is there any real magic?"

If S did imitate E's words or gestures, E said:

> It's hard, isn't it? You have to know something special. Let me see if you can do it if I hold the bag (E took bag and unlocked the handle). Now try. (After S tried his words and/or gestures, E reached into bag with fist concealing cat and removed it, showing cat.) There's the cat! Did you do magic?

Scoring

Ss were scored as passing (+) or failing (-) each of the following items:

1. Has concept of magic

   +: a. Spontaneously mentions magic
   b. Says there is no such thing as magic; doesn't believe in magic
   c. Says magic caused cat to really turn into bird; yes on Q3 and real on Q9 and no admission of not knowing what magic is
   d. Gives examples of other types of magic, e.g., pulling rabbit out of hat
   e. Asks if he can do it or spontaneously tries; asks if it will make a monster, etc.

2. Knows the original object remains in the situation in some form

   +: Gives no indication of belief that cat merely went away or disappeared
   a. Says the cat is in the bag
   b. Says the cat "must be around somewhere"
   c. Knows the cat didn't go away physically to place out of E's reach
   d. Suggests or accepts notion of transformation

3. Has at least some doubt that event is a real transformation or disembodiment phenomenon

   +: Evidences suspicion or uncertainty about occurrence of real change
      a. Says no to Q3 and does not suggest that toy disappeared
      b. Says "There's a trick to that," or "I don't believe it," etc.
      c. Tries to look inside or examine bag
      d. Questions the extent of E's skill

4. Hypothesizes use of two animals in bag

   +: a. Says hidden object is still in bag or searches for it
      b. Says E is just taking out one at a time

5. Resists magical explanation of apparent event

   +: Says is not real magic at some point (and differentiates real from pretend magic, if says is pretend). Does not believe pretend magic is an actual change. Does not say bag is magic.

6. Suggests a physicalistic explanation after viewing turning of bag inside out

   +: a. Says E displaced object somewhere else, e.g., "You dumped it out someplace," or "You took it out and put it down beside you," or "I think you have it in your hand," etc.
      b. Says the object is hidden in the bag, e.g., "The duck was under some black yarn," or "There must be a pocket."
      c. Says there is a method which causes the apparent change, e.g., "You learned how to do it from a book," or "You're the only one who knows what to do," etc.

7. Believes a substitution has occurred after bag is turned inside out

   +: Continued to maintain that two toys are somehow involved, and that one is being taken out of the bag at a time, even after viewing reversal of bag; may indicate this belief by searching for the cat.

8. Believes the phenomenon is not a real event

   +: a. Believes it is not a real transformation: says one did not turn into the other and does not suggest disappearance or request that E turn it into something else.

9. Believes he did not cause change when E held bag and S said magic words

   +: Says he didn't do real magic

10. Totally rejects magical cause of phenomenon

   +: Does not even consider possibility of magical cause, including his effectance of change.

11. Denies any belief in magic in any context

+: Says no to Q15 and disavows magic throughout interview

-: Only magician can do magic -- "Are you a magician?"
Says no to Q15 but says magic exists under certain circumstances
No, except maybe a genie, the kind that come in bottles
Says D.K. whether there is magic or 'don't think so'
Says D.K. whether event is magic

12. Disbelieves mystical cause of event with certainty

+: Does not even consider possibility of non-concrete, physical cause
Does not believe change can be effected merely with words and gestures

In addition, verbalized hypotheses about what happened to the cat were scored as follows:

1. It just happened, e.g., "The bag did it," "It's just magic."

2. The cat disappeared, "It's gone -- vanished."

3. Cat is somewhere else outside or inside of trailer, but E is not viewed as causal agent.

4. Cat turned into a bird or changed into a bird, e.g., "It grew," "It really changed into a bird."

5. The cat is in the bag, and E just took out another toy.

6. E put cat somewhere else in the trailer.

7. After the bag is turned inside out, insists cat is in the bag, but no mention of specific artifice.

8. Bag conceals artifice of some sort.

Results

A scalogram analysis using Green's (1956) summary statistics was performed (see Table 59) which indicated that the set of elevan items presented above forms a Guttman scale. Table 60 shows the median age and frequency of bright, average, and retarded Ss who score at the twelve scale levels.

Developmental Sequentiality of Acquisition

Several lines of evidence converge to suggest that the Guttman scale

TABLE 59

RESULTS OF SCALOGRAM ANALYSIS[a] OF MAGIC ITEMS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.988143	.97628	.99351
Chance Reproducibility	.844860	.902917	.88765
Index of Consistency	.92357	.755724	.94223

[a]Using Green's (1956) summary statistics

TABLE 60

MEDIAN AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS SCORING AT TWELVE LEVELS ON THE MAGIC SCALE
(N=134)

Scale Types	SCALE ITEMS											BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	7	8	9	10	11	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
11	+	+	+	+	+	+	+	+	+	+	+	5	0	91	1	0	96	9	0	108
10	+	+	+	+	+	+	+	+	+	+	-	6	0	88	0	1	-	0	0	-
9	+	+	+	+	+	+	+	+	+	-	-	2	0	79	0	1	-	0	1	-
8	+	+	+	+	+	+	+	+	-	-	-	4	0	92	1	0	79	3	0	114
7	+	+	+	+	+	+	+	-	-	-	-	4	0	85	3	0	90	2	0	112
6	+	+	+	+	+	+	-	-	-	-	-	1	1	82	2	0	93	3	0	122
5	+	+	+	+	+	-	-	-	-	-	-	3	1	68	0	2	-	4	0	102
4	+	+	+	+	-	-	-	-	-	-	-	3	1	75	10	2	75	5	1	108
3	+	+	+	-	-	-	-	-	-	-	-	0	0	-	1	2	91	0	1	-
2	+	+	-	-	-	-	-	-	-	-	-	12	0	67	16	0	81	14	0	99
1	+	-	-	-	-	-	-	-	-	-	-	2	0	79	4	0	67	5	0	96
0	-	-	-	-	-	-	-	-	-	-	-	$\frac{0}{42}$	$\frac{0}{4}$	-	$\frac{0}{38}$	$\frac{0}{8}$	-	$\frac{1}{39}$	$\frac{0}{3}$	87
n	131	117	78	73	59	44	38	28	20	19	9									
$\bar{n}$	3	17	56	61	75	90	96	106	114	115	125									

describes a developmental sequence of acquisition:

1. The items are ordered in terms of increasing difficulty. Reproducibilities and indices of consistency shown in Table 59 indicate that the items are increasingly difficult as one moves from one to eleven. This order is the same for all IQ groups.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 60 showed a general median age increase from lowest to highest scale levels, and mean scores shown in Table 61 indicate a regular increase in performance with increased age which is statistically significant ($F=25.77$, $df=2, 86$, $p < .0001$ for average and bright groups). Table 62 shows that older children tend to score at levels higher than do younger children, and Table 63 shows a regular age increase in percentage of Ss succeeding on each scale item.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 64 shows scale scores of Ss at two points in time, separated by one year. Of the 18 Ss (one was unscorable on the first testing), 2 Ss scored at the same level on both testings, 12 Ss scored at a higher level on the second testing, and 4 Ss scored at a lower level at the end of the year. For most Ss, the scale provides a good account of their developmental change.

Effect of Intelligence on Performance

Table 61 shows a significantly higher level of performance for bright children than average ($F=20.66$, $df=1, 86$, $p < .0001$), but no statistically significant difference between average and retarded children of the same mental age.

Effect of Sex on Performance

None of the differences in performance of the sexes is statistically significant.

TABLE 61

MEAN MAGIC SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	2.62	2.38	2.50	3.14	2.12	2.60	2.50	2.00	2.31
6	5.57	7.25	6.47	4.12	4.00	4.06	4.62	3.43	4.07
7	8.50	8.88	8.69	5.25	3.75	4.50	4.62	6.14	5.33
Mean All Ages	5.56	6.17	5.87	4.22	3.32	3.75	3.92	4.05	3.98

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 62

PERCENTAGE OF MAGIC SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=139)

Ability Group	Age	0	1	2	3	4	5	6	7	8	9	10	11
Bright	5 (N=16)	00	00	81	00	06	13[c]	00[c]	00[c]	00	00	00	00
	6 (N=15)	00	14	00	00	14	14	06	14	06	13	13	06
	7 (N=16)	00	00	00	00	06	00	06	19	19	00	25	25
Average	5 (N=15)	06	20	27	13	27	00	07	00	00[b]	00	00[b]	00
	6 (N=17)	00	00	41	00	29	12	00	06	06	00	06	00
	7 (N=16)	00	06	31	06	19	00	12	12	00	07	00	07
Retarded	5 (N=13)	08	15	54	00	08	15	00	00	00	00	00	00
	6 (N=15)	00	20	26	07	20	00	00	06	07	07	00	07
	7 (N=15)	00	00	20	00	20	13	20	07	13	00[b]	00	07

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=14

[c] N=15

TABLE 63

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN SUCCEEDING ON EACH MAGIC SCALE ITEM AT THREE AGES[a] (N=139)

Ability Group	Age	1	2	3	4	5	6	7	8	9	10	11
Bright	5 (N=16)	100	100	19	19	13[c]	06[c]	00[c]	00	00	00	00
	6 (N=15)	100	86	86	86	67	67	53	40	33	20	06
	7 (N=16)	100	94	100	94	100	81	88	75	56	56	25
Average	5 (N=15)	80	73	46	40	13	00	06	00[b]	00	00[b]	00
	6 (N=17)	100	94	59	53	29	18	18	12	06	12	06
	7 (N=16)	100	88	56	44	50	38	31	12	12	12	00
Retarded	5 (N=13)	92	96	23	23	15	00	00	00	00	00	00
	6 (N=15)	100	60	46	46	40	26	26	20	13	13	06
	7 (N=15)	100	100	80	80	60	46	26	20	07[b]	06	06

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=14

[c] N=15

TABLE 64

FREQUENCY OF MAGIC SCALE SCORES OBTAINED BY SUBJECTS AT TWO POINTS IN TIME, SEPARATED BY ONE YEAR (N=18)

First Testing Scale Score	Second Testing Scale Score											
	0	1	2	3	4	5	6	7	8	9	10	11
0			1									
1			1									
2		2	2		3	1			1		1	1
3												
4			1				1			1		
5					1							
6											1	
7												
8												
9												
10												
11												

CONSTANCY OF SEX-ROLE IDENTITY

METHOD

The method used in assessing the ability to maintain constancy with regard to sex-role was developed by Kohlberg (1965, 1966; Kohlberg and Zigler, 1967). Four black-and-white schematic drawings were used which show 1) girl in dress, with long hair, 2) girl in dreww with crew-cut hair, 3) girl with long hair, in boy's clothes, and 4) boy with crew-cut in boy's clothes.

Procedure

The child was seated at a child-sized desk on which the pictures were placed as E presented the identity problems. E first ascertained that S perceived Picture 1 as a girl by presenting it and asking, "Is this a boy or a girl?" E then affirmed S's perception by saying, "Yes, it's a girl, isn't it?"

Item 1 was designed to assess whether S believed that mere desire for sex-role identity change would be sufficient to bring about such a change. E said:

> If this child (pointing to Picture 1 of girl) really wants to be a boy, can she?
> (If S said no): Why not?
> (If S said yes): Would the child be a real boy then?
> (If S said not real boy): What would it be?
> (If S said it would be a girl): Why would it still be a girl?
> (If S said it would be partly a boy): Would it be partly a real boy?

The above probe questions were used for all the following test items, but are not repeated below.

Item 2 explored the child's belief about the possibility of a sex-role change when behavioral transformation was suggested. E said:

> If this child (pointing to Picture 1) plays with guns and does boy things, what would it be? Would it be a boy or a girl?

Items 3a and 3b focussed on assessing the child's belief about sex-role identity when one change in physical appearance was made. E said:

3a. If this child's hair (pointing to hair in Picture 1) were cut short like this (pointing to crew-cut hair of girl in Picture 2), what would it (pointing to Picture 1) be? Would it be a boy or a girl?

3b. If this child (pointing to girl in Picture 1) put on boy clothes like this (pointing to Picture 3), what would it (pointing to Picture 1) be? Would it be a boy or a girl?

Item 4 was designed to evaluate the effect of two appearance changes on the child's belief about sex-role constancy. E said:

If this child's (pointing to girl in Picture 1) hair were cut like this (pointing to hair of child in Picture 2), and the child wore boy's clothes like this (putting Picture 4 on top of Picture 2 and pointing), what would the child (pointing to Picture 1) be? Would it be a boy or a girl?

Item 5 explored the child's belief about sex-role identity in the face of a behavioral change and two appearance changes. E said:

If this child (pointing to girl in Picture 1) had hair and clothes like a boy (pointing to Picture 4) and played with guns and did boy things and acted like a boy, what would the child (pointing to Picture 1) be? Would it be a boy or a girl?

Item 6 was added to Kohlberg's interview in order to elicit verbalized reasons and to assess whether the child distinguished between the possibility of sex-role change for pictured as opposed to real persons. E said:

Could that really happen?
(If no:) Why not? If a real girl cut off her hair like a boy and played with guns and acted like a boy, would the real girl be a real boy? Why does a girl have to stay a girl?

(If yes): Does that happen sometimes? Did you ever know a girl who changed to a boy?

Scoring

Ss were scored as passing (+) or failing (-) the following items:

1. At least resists suggestion that girl can become boy.

   a. Says it doesn't look like a boy
   b. Says one picture is girl, and one is boy
   c. Says neither girl nor boy
   d. Suggests counter girl-attribute or lack of some boy attribute
   e. Says is girl and boy
   f. Says it's nothing
   g. Says doesn't know what it is

h. Contradicts specific suggestion in question, e.g.,
   Q 1: She wants to be a girl
   Q 2: Girls don't know how to do boy things
   Q 3: The hair would grow back
i. Says girl can't be boy if she wants to, but then suggests a way
j. Says, "I don't want it to"
k. Says is girl still on any question
l. Simply "cannot change"
m. Moral reason (including "God")
n. Girl is made different from boy
o. Girls like to play with boy things
p. Suggested change makes no difference
q. There's no such things as . . .
r. Irrelevant statement
s. States constancy principle, e.g., "It's born a boy."
t. Repeats suggested change
u. Magic can't change her

2. Says girl can not be boy at some point.

   Says girl cannot be boy on any question

3. Says girl cannot be a real boy if she wants to.

   Says no, or not real boy on Q1
   Note: If says no on Q1, but suggest some way, e.g., magic, God, etc., + is given on Item 1 and 3 but - is given on Item 8.

4. Says girl will not be a real boy if it played with guns and did boy things.

   Says is still girl or not real boy on Q2

5. Says girl will not be a real boy if her hair is cut short or if she puts on boy clothes.

   Says is still girl on Q3a and 3b, or is not real boy

6. Says girl will not be a real boy if her hair is cut short and she wears boy clothes.

   Says is still girl on Q4, or is not real boy

7. Says such a change cannot really happen.

8. Says girl will not be a real boy if she has hair and clothes like a boy's and plays with guns and does boy things.

   Says is still girl on Q5, or is not real boy

9. Says girl will not and could not be a boy and maintains this with no contradiction.

   Never says girl will or can be real boy

In addition, verbal reasons were scored according to the same system presented in the foregoing chapter on development of generic identity.

Results

A scalogram analysis using Green's (1956) summary statistics was performed (See Table 65) which indicated that the set of nine items presented above forms a Guttman scale. Table 66 shows the median age and frequency of bright, average, and retarded Ss who score at the ten scale levels.

Developmental Sequentiality of Acquisition

Several lines of evidence converge to suggest that the Guttman scale describes a developmental sequence of acquisition:

1. The items are ordered in terms of increasing difficulty. Reproducibilities and indices of consistency shown in Table 65 indicate that the items are increasingly difficult as one moves from one to eleven. This order is the same for all IQ groups.

2. Increasing success on scale items tends to occur with increasing age and reflects the order of difficulty. Table 67 shows an increase in mean level of performance from age five to age six, but not always an increase from six to seven years. The analysis of variance indicated the age effect to be significant ($F=4.14$, $df=2, 86$, $p < .02$ for bright and average groups). Table 68 shows that older children tend to score at higher levels than younger children, and Table 69 shows a general increase in percentage of Ss succeeding on each scale item with increasing age, though this is not so clear for average children.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 70 presents scale scores of Ss at two points in time, separated by one year. Of the 19 Ss, 5 Ss scored at the same level on both testings, 10 Ss scored at a higher level, and 4 Ss scored at a lower level on the second testing. While these apparent

TABLE 65

RESULTS OF SCALOGRAM ANALYSIS[a] OF SEX-ROLE CONSTANCY ITEMS FOR BRIGHT, AVERAGE, AND RETARDED GROUPS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.9845	.9838	.9630
Chance Reproducibility	.8596	.8731	.8622
Index of Consistency	.8896	.8724	.7313

[a]Using Green's summary statistics

TABLE 66

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS SCORING AT TEN LEVELS ON THE SEX-ROLE CONSTANCY SCALE (N=136)

Scale Type	SCALE ITEMS									BRIGHT			AVERAGE				RETARDED	
	1	2	3	4	5	6	7	8	9	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
9	+	+	+	+	+	+	+	+	+	22	-	82	8	-	78	15	-	108
8	+	+	+	+	+	+	+	+	-	0	3	-	0	1	-	0	1	-
7	+	+	+	+	+	+	+	-	-	1	1	68	4	0	82	3	4	102
6	+	+	+	+	+	+	-	-	-	2	0	88	2	3	90	3	3	96
5	+	+	+	+	+	-	-	-	-	2	0	68	6	1	76	2	3	116
4	+	+	+	+	-	-	-	-	-	2	1	62	7	2	72	1	2	118
3	+	+	+	-	-	-	-	-	-	7	0	69	8	0	74	2	2	112
2	+	+	-	-	-	-	-	-	-	0	0	-	2	0	70	2	0	129
1	+	-	-	-	-	-	-	-	-	0	0	-	0	0	-	0	0	-
0	-	-	-	-	-	-	-	-	-	2 / 38	- / 5	84	4 / 41	- / 7	83	2 / 30	- / 15	94
n	128	128	120	102	88	69	65	61	50									
$\bar{n}$	8	8	16	34	48	67	71	75	86									

TABLE 67

MEAN SEX-ROLE CONSTANCY SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=142)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.62	6.62	5.62	4.67	3.88	4.29	4.62	6.00	5.15
6	7.75	7.50	7.62	5.12	6.33	5.76	7.25	6.25	6.75
7	8.75	6.75	7.75	4.75	5.12	4.94	7.38	5.75	6.56
Mean All Ages	7.04	6.96	7.00	4.84	5.16	5.00	6.42	6.00	6.15

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 68

PERCENTAGE OF SEX-ROLE CONSTANCY SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=143)

Ability Group	Age	0	1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	00	00	00	31	19	12	00	06	00	31
	6 (N=16)	06	00	00	06	00	00	06	06	06	69
	7 (N=16)	06	00	00	06	00	00	06	00	12	69
Average	5 (N=17)	00	00	06	24	29	24	12	00	00	06
	6 (N=17)	18	00	06	06	00	06	12	12	06	35
	7 (N=16)	06	00	00	19	25	12	12	12	00	12
Retarded	5 (N=13)	15	00	00	08	15	15	08	15	00	23
	6 (N=16)	00	00	00	19	00	00	19	25	06	31
	7 (N=16)	00	00	12	00	06	19	12	06	00	44

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 69

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED CHILDREN SUCCEEDING ON EACH SEX-ROLE CONSTANCY SCALE ITEM AT THREE AGES[a] (N=143)

Ability Group	Age		1	2	3	4	5	6	7	8	9
Bright	5	(N=16)	100	100	94	69	62	38	17	31	31
	6	(N=16)	94	94	94	88	88	81	75	81	75
	7	(N=16)	94	94	94	81	88	88	67	81	81
Average	5	(N=17)	100	100	94	62	35	06	19	12	00
	6	(N=17)	82	82	76	71	65	59	50	47	41
	7	(N=16)	94	94	94	69	50	31	31	19	12
Retarded	5	(N=13)	84	84	76	69	46	38	54	46	23
	6	(N=16)	100	100	94	88	81	69	56	56	38
	7	(N=16)	100	100	81	88	81	62	50	56	44

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 70

FREQUENCY OF SEX-ROLE CONSTANCY SCALE SCORES OBTAINED BY SUBJECTS AT TWO POINTS IN TIME, SEPARATED BY ONE YEAR (N=19)

First Testing Scale Score	Second Testing Scale Score									
	0	1	2	3	4	5	6	7	8	9
0						1		1		
1										
2										
3	1			2						1
4	1		1							1
5										3
6							1			2
7										1
8										
9						1				2

regressions are troublesome and require further investigation, the scale does account for performance change for most Ss.

Effect of Intelligence on Performance

Table 67 indicated a higher level of performance for bright children, and the analysis of variance showed this difference to be statistically significant ($F=14.56$, $df=1, 86$, $p < .0003$ for bright and average groups). However, Table 67 also shows a higher level of performance for retarded children than average children, and this difference is also statistically significant ($F=4.65$, $df=1, 83$, $p < .03$).

Effect of Sex on Performance

The performance of boys does not differ significantly from that of girls, although the interaction among sex, age, and IQ for bright and average children approaches significance ($F=2.32$, $df=2, 86$, $p < .10$). Bright girls perform better than boys at age five, but worse than boys by age seven, whereas the reverse trend is the case for average children. Average girls do worse than boys at age five and better than boys at ages six and seven.

DREAM CONCEPTS

METHOD

Assessment of S's beliefs about the nature and causality of dreams made with Kohlberg's (1966) dream interview.

Procedure

The interview began by ascertaining that S knew what a dream was, by establishing that the subject of discussion was dreams occurring while asleep, and by eliciting an account of a dream experience. E said:

> You know what a dream is, don't you? Do you dream sometimes during the night? Can you have a dream if you stay awake and don't go to sleep? What did you dream about last time? Tell me a dream you had.

Subsequent questions pertain to the substantiality of a dream object and to whether the S recognizes a difference between waking and sleeping experiences. E asked:

> 3a. What happened after the dream was over? What did you think and do? What happened to the (object) after you woke up? Where did it go? Where was it after you woke up?
>
> (If S said it disappeared): Could you see it leaving? (If S did not say it disappeared): Could you see it when you woke up?
>
> When you see a dog in a dream, is it the same as when you are awake at night and see a dog?

S's differentiation of real and unreal was explored at a very low level, partly to ascertain that some verbal distinction was made prior to probing beliefs about reality of dream. E said:

> What is this (showed color photograph of dog)? Is this a real dog you see here, or is it a picture, just something that looks like a dog?
>
> (If S said real): Can this dog you see here bark or run? Can he come out of the picture and run away?
>
> 3c. Was the (object) you saw in your dream just pretend, just something that looked like a (object), or was it a real (object)?
>
> 3d. Was the (object) in your dream really there where you were, really close to you, or did it just seem to be there?

(If S said really there): Could you touch the (object) and, (smell or other appropriate sense) it?

Beliefs about the origin of the dream were probed by asking:

5. Tell me, where does a dream come from?
Where are dreams made, where do they come from?
Do they come from inside you or outside of you?
Who makes the dreams come out? Is it you or somebody else?

Beliefs about the location of the dream were explored by inquiring as follows:

6. While you are dreaming, where is your dream; where does it go? Is it inside of you or in your room?

(If S said dream was in the head, thoughts, etc., indicating internal location): If we could open your head (or other location mentioned by S) while you are dreaming, if we could look into your head without hurting you, could we see your dream?

(If S said no): Why do you say that we could not see your dream?

7. (If S said dream was in the room, on the wall, close to his eyes, under the bed, etc.): Is it only that the dream seems to be in your room (or wherever S said), or is it really in your room?

(If S said not really there): Where is the dream then?

Beliefs about the visibility of the dream to others were investigated by asking:

4. If your mother is in your room while you are asleep and dreaming, can she also see your dream?

(If S said no): Why not? How about me? Could I see your dream if I were in your room while you were dreaming?

Beliefs about the materiality of dream substance was probed by asking:

8. What is a dream made of?
Is it made of paper?
Then, what is it made of?
Can we touch dreams?
Is a dream a thought or is it a thing?

Beliefs about the causality of dreams was investigated by asking:

9. When you had the dream about the (object), why did you have that dream? What made you have that dream?

Then do you know why we dream, why there are dreams?

If S said he didn't dream at the beginning of the interview, he was again asked to tell a dream. If he still did not, E said:

> Let's make believe that you dream during the night about a monkey. Would it just seem that the monkey was there, or would the monkey really be there?
>
> Let's make believe you dream about a monkey during the night. What would make you dream about that, why would you have that dream?
>
> Then do you know why we dream, why there are dreams?

Scoring

Ss were scored as passing (+) or failing (-) the following items:

1. Knows what a dream is

   +: Says he knows what a dream is
   Gives an example of a dream which is clearly not an account of real experience
   Says he can't have a dream if he stays awake and doesn't go to sleep
   Says he can have a dream if he stays awake, but differentiates a daydream from a nightdream

2. Partly aware of the unreality of the dream

   +: Makes some statement to indicate that dream object or event is not real
   Answers either Q3c or Q3d to indicate that dream object is not real

3. Fully aware of the unreality of the dream

   +: On Q3c, says object was not a real object and on Q3d, says object was not really there and that he could not sense it

   Note: Score + on this item if Q3c and Q3d are answered as above, even if response to Q3a suggests belief in presence of object

4. Dream is not visible to others

   +: Says mother and E could not see his dream
   Says mother or E could only see it if they went to sleep and dreamed the same thing

   Note: Score "-" if says another can't see the dream because it would run under the bed, or suggests another obstacle which indicates belief that if the obstacle weren't present, the dream would be visible

5. Dreams have some internal origin or locus

   +: Says dreams come from inside
   Says he makes the dreams come out
   Names some internal location of dream
   Says dream just seems to be there
   Says dream comes from outside, but from God

6. Dreams are entirely internal in origin and may take place inside

   +: All responses concerning origin indicate belief in internality and at least one response suggests some belief in internality of locus

7. Sure dreams take place inside

   +: Replies correctly to all questions about the location of the dream -- where it takes place. May believe that dreams come from God or heaven, but if so, believes that the dream goes inside the body or head before its occurrence.

8. Dreams are immaterial

   +: Names no physical substance in response to "What are dreams made of?"
   Says dreams are not made of paper
   Says he can't touch dreams
   Says dream is a thought, not a thing
   Says cannot see dream if head is opened
   Says dreams are invisible in response to "Why couldn't we see your dream?"

9. Dreams are caused in a purely subjective or immaterial fashion by the child himself

   +: Responds to "Who makes dreams come?" by referring to self, mind
   " " " " " " " " " "
   Gives some explanation of having perceived or heard about the dreamed about object or event; some explanation of its having made an emotional impression or its having been thought about prior to the dream.

In addition, responses to "Why do we dream?" were categorized as follows:

1. No reason or irrelevant reason given, e.g., "I don't know," "Because we dream."

2. Dream is viewed as a personal effect or reaction, as a result of personal desire, or merely as a necessary event, e.g., "I want to," "I like to," "I'm supposed to," "We'll die if we don't," "To help people," To make us feel better," "To make us grow," "To make us scared," "To make us sad," "To help us sleep," "To make us laugh," "To teach us a lesson," "To teach us a (fact)," "So we won't be bored while we're asleep," "It just comes; I can't stop it," "Because we close our eyes," "I decided to dream about _____," "If I say 'witches,' I'll dream about them," "Because I want a _____ (something S wants or wants to do when awake)."

3. Dream is arbitrary result of external cause, e.g., "_____ (witch, God, Jesus, Dream Man, fairy, Bad Dreamer, somebody else) shows the dream (or makes it happen)."

4. Dream is direct result of specific experience or thought occurring when awake, e.g., "I was thinking about it before I went to sleep," I did that and then thought about it later," "I saw it on TV and then dreamed about it."

5. Dream is indirect result of specific experience, e.g., "I ate too much before going to bed," "There was a storm," "I stayed up too late."

6. Dream is self caused, e.g., "It's just imagination," "It's thinking," "It's my mind."

Results

A scalogram analysis using Green's (1956) summary statistics was performed (See Table 71) which indicated that the set of nine items presented above forms a Guttman scale. Table 72 shows the median age and frequency of bright, average, and retarded Ss who score at the ten scale levels.

Developmental Sequentiality of Acquisition

Several lines of evidence converge to suggest that the Guttman scale describes a developmentalsequence of acquisition:

1. The items are ordered in terms of increasing difficulty. Reproducibilities and indices of consistency shown in Table 71 indicate that the items are increasingly difficult as one moves from one to nine. This order is the same for all IQ groups.

2. Increasing success on scale items tends to occur with increasing age and reflects the order of difficulty. Table 73 shows an increase in mean level of performance with increasing age, and the analysis of variance indicates that age is a statistically significant factor affecting performance ($F=13.30$, $df=2, 85$, $p < .0001$ for bright and average children). Table 74 shows that older children tend to score at higher levels than do younger children, and Table 75 shows an increase in percentage of Ss succeeding on each scale item with increasing age.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 76 presents scale scores of Ss at two

TABLE 71

RESULTS OF SCALOGRAM ANALYSIS[a] OF DREAM ITEMS FOR BRIGHT, AVERAGE, AND RETARDED GROUPS

Ratios Computed	Bright (N=40)	Average (N=42)	Retarded (N=33)
Reproducibility	.98057	.94180	.94950
Chance Reproducibility	.93906	.88094	.87710
Index of Consistency	.68116	.51117	.58909

[a]Using Green's (1956) summary statistics

TABLE 72

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS SCORING AT TEN LEVELS ON THE DREAM CONCEPTS SCALE (N=115)

Scale Score	ITEMS									BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	7	8	9	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
9	+	+	+	+	+	+	+	+	+	18	-	89	5	-	87	6	-	114
8	+	+	+	+	+	+	+	+	-	9	1	78	0	4	-	5	2	108
7	+	+	+	+	+	+	+	-	-	2	3	78	5	3	68	3	3	100
6	+	+	+	+	+	+	-	-	-	1	1	81	4	2	81	1	1	113
5	+	+	+	+	+	-	-	-	-	2	1	69	4	5	83	4	2	98
4	+	+	+	+	-	-	-	-	-	1	0	63	3	2	69	2	0	91
3	+	+	+	-	-	-	-	-	-	1	0	61	1	0	71	0	1	-
2	+	+	-	-	-	-	-	-	-	0	0	-	2	2	63	2	0	87
1	+	-	-	-	-	-	-	-	-	0	0	-	0	0	-	1	0	118
0	-	-	-	-	-	-	-	-	-	0/34	-/6	-	0/24	-/18	-	0/24	-/9	-
n	115	111	103	99	99	74	64	57	45									
$\bar{n}$	0	4	12	16	16	41	51	58	70									

TABLE 73

MEAN DREAM ANALYSIS SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	5.38	7.38	6.38	4.22	5.71	4.88	4.50	4.50	4.50
6	8.12	7.50	7.81	6.50	6.33	6.41	6.29	5.62	5.93
7	9.00	8.50	8.75	6.12	7.00	6.56	7.00	7.00	7.00
Mean All Ages	7.50	7.79	7.64	5.56	6.38	5.96	5.91	5.95	5.93

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 74

PERCENTAGE OF DREAM CONCEPTS SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=140)

Ability Group	Age	Scale Score 0	1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	00	00	06	06	06	19	06	19	19	19
	6 (N=16)	00	00	00	00	00	00	12	19	44	25
	7 (N=16)	00	00	00	00	00	00	00	06	12	82
Average	5 (N=16)	00	00	19	06	19	19	06	25	06	
	6 (N=17)	00	00	06	00	12	18	18	00	34	12
	7 (N=16)	00	00	00	00	06	19	25	31	00	19
Retarded	5 (N=12)	00	08	17	00	25	17	08	25	00	00
	6 (N=15)	00	00	06	06	06	33	00	20	13	13
	7 (N=16)	00	00	00	06	00	25	06	06	32	25

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 75

PERCENTAGE OF BRIGHT, AVERAGE AND RETARDED CHILDREN SUCCEEDING ON EACH DREAM CONCEPT SCALE ITEM AT THREE AGES[a]

(N=140)

Ability Group	Age	Scale Item 1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	100	94	94	88	81	61	50	44	25
	6 (N=16)	100	100	100	94	100	94	81	75	38
	7 (N=16)	100	100	100	100	100	100	100	94	81
Average	5 (N=16)	100	94	81	75	50	38	31	12	06
	6 (N=17)	100	88	82	82	94	59	41	47	47
	7 (N=16)	100	100	100	94	88	62	38	44	31
Retarded	5 (N=12)	100	92	58	67	67	33	25	08	08
	6 (N=15)	100	100	94	88	100	62	56	56	44
	7 (N=16)	100	100	94	88	100	62	56	56	44

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 76

FREQUENCY OF DREAM CONCEPT SCALE SCORES OBTAINED BY SUBJECTS AT TWO POINTS IN TIME, SEPARATED BY ONE YEAR (N=19)

First Testing Scale Score	Second Testing Scale Score									
	0	1	2	3	4	5	6	7	8	9
0										
1						1				
2			1							
3								1		
4								1	1	
5							1	2		
6										2
7					1				2	2
8						1		2		1
9										

points in time, separated by one year. Of the 19 Ss, only 1 S scores at the same level on both testings, 14 Ss perform at higher levels at the second testing, and 4 Ss perform at lower levels. Thus, the scale does account for performance change for most Ss.

Effect of Intelligence on Performance

Table 73 indicates that bright children perform at a higher level than average children, and the analysis of variance showed that the difference is statistically significant ($F=26.62$, $df=1, 85$, $p < .0001$ for bright and average groups). However, average children do not differ significantly from retarded children of the same mental age in their acquisition of mature concepts about dreams.

Effect of Sex on Performance

Table 73 shows that both average and bright girls are superior to boys at age five and that the difference not only lessens at older ages, but that by age seven, bright girls perform less well then boys. This sex difference approaches significance ($F=3.07$, $df=1, 85$, $p < .08$), and the interaction of sex with age is statistically significant ($F=3.71$, $df=2, 85$, $p < .03$).

CONSERVATION OF QUANTITY IN RING-SEGMENT ILLUSION

METHOD

The method used to assess conservation of quantity in an illusion situation utilized ring-segment cookies which produced the Jastrow effect. Green, red, and blue cookies were $3\frac{1}{4}$-inches wide, and white cookies were 3-inches wide.

Procedure

A sheet of black formica (about 8" x 14") was placed on the desk before the child. A pre-test item was included in order to measure response latency in a situation likely to induce conflict. Two ring-segment cookies, identical in size and color, were placed side by side on the formica. E kept the cookies concealed until she completed the following instruction:

> I have two cookies here, and in a minute I'm going to let you pick the bigger one that has more to eat. But if you don't pick the one that has more to eat, you won't get a cooky this time. You'll get another chance later. Now, look at them and point to the one that has more cooky to eat.

E Revealed cookies, allowed S to select the one he believed to be bigger, and permitted S to take the cooky and put it in his paper sack.

A prediction question was included to explore S's expectancy of constancy in the size relationship of two unequal cookies. E placed one white and one green cooky on the desk, with the green cooky below in the illusion position. (Note that the larger cooky was placed so that it appeared larger.) E said:

> Here are two cookies. Look at them. Can you see that one is bigger and has more to eat than the other? When I say so, you may pick the one with more to eat. If you don't pick the one with more to eat, you won't get a cooky this time. You'll get another chance later. Now, before you pick, I put them like this. (E placed 3 x 5-inch card over cookies so that only about $\frac{1}{4}$-inch of the left side of each cooky was visible and then slid the green cooky to the top position.) Now, if you can show me the one with more to eat, you may have it.

S was allowed to take the cooky he chose.

The first test item was designed to assess E's conservation of quantity in the context of the strong illusion of the Jastrow effect. The problem presented to S was identical to that in the Prediction Question, except that no care cover was used. After the child made his selection, E asked:

> How could you tell that was more to eat?
> Is one cooky bigger? Which is bigger? How can you tell?

If S chose the bigger green cooky, even though it appeared smaller in the illusion, he was allowed to take the green cooky, and E then presented Test Item 3. If the child selected the smaller white cooky in the lower illusion position, E asked Test Item 2.

Test Item 2 was designed to explore the limits of the nonconservers' beliefs about the inconstancy and to find whether calling attention to the original relationship would assist S in maintaining constancy. After S's choice of the smaller white cooky in the lower position on Item 1, E said:

> Look, here's the one you picked (pointing to white). Now, I put it here (E moved white cooky to upper position). Does it still have more to eat than the other cooky? Or, does this one (pointing to green in lower position) have more to eat now?

If S maintained constancy in his prior choice and selected the white cooky in the upper position, thereby ignoring the illusion, E said:

> How did you know this has more to eat?
> Is one bigger? Which is bigger? How can you tell?

If S selected the green cooky in the upper position, thereby responding to the appearance of the illusion and denying the choice previously made, E said:

> How is that? How could you tell?
> Which had more to eat when this (pointing to white) was here (pointing to space below green)?

If S said white had more, E asked:

Did it really change? Did it really get to be more to eat?

If S then said green had more, E asked:

How is that (moving green back to top position)? Here is the way it was before. Does it have more to eat now?

Items 3 and 4 were designed to more directly elicit conflict and explore beliefs about the cause of the apparent transformation. E said:

3. Here are two more cookies (blue and red cookies, identical in size, were presented with blue in lower position). You can pick the one with more to eat when I say so. Now this is harder. Look at them. Before you pick, I change their places (blue cooky was moved to upper position). Now look at them. Which has more to eat? How did you know? How could you tell?

If the child chose the blue cooky in the upper position, E moved to Item 4. However, if the child chose the red cooky in the lower position as having more to eat, E asked the following:

Which had more to eat when this (pointing to red) was here (pointing to position above blue cooky)?

If S said the red cooky had more then, E said:

Here's the way it was before (moving blue cooky to lower position). Does it have more to eat now?

If the child said the red cooky in the upper position had more to eat, E moved to Item 4. However, if the child said the blue cooky in the lower position then had more to eat, E asked:

Did it really get to be more to eat? Did it get bigger? What happened?

If the child chose the blue cooky in the upper position, E moved to Item 4. However, if S chose the red cooky in the lower position as having more to eat, E asked the following:

Which had more to eat when this (pointing to red) was here (pointing to position above blue cooky)?

(If S said red): Here's the way it was before (moving blue cooky to lower position). Does it have more to eat now? (If S said red in upper position still had more to eat, E moved to Item 4. If S said blue had more to eat, E continued.) Did it really get to be more to eat? Did it get bigger? What happened?

(If S said blue): Did this (pointing to red) really get to be more to eat? Did it get bigger? What happened?

4. Look, it looks like they change (E switched red cooky from upper to lower position and back several times, leaving it in upper position if red was last chosen as more to eat, and in lower position if blue was last selected as more). Which has more to eat? Is one bigger?

What happens? Does it really change from big to small when I move it or what?

Item 5 was included to explore the child's spontaneous utilization of measurement and the effect of seeing the cookies superimposed on beliefs about the transformation. E said:

Show me how you can tell which is really the big one.

(If S did not measure): If I thought this (cooky child did not last choose as bigger) is the bigger one, how could you show me it isn't?

(If S still did not measure): Can you measure them?

(If S still did not measure): Can you put them together to see which is bigger and has more to eat?

(If S did not superimpose): Which is bigger now (E superimposed cookies)? How about now (E placed cooky last selected as bigger in upper position)? How does that happen?

Scoring

Subjects were scored as passing (+) or failing (-) the following items:

1. Remembers which cooky appeared bigger before change in array

+: a. Says white cooky had more before on Q2b
b. Says blue cooky had more before on Q3c
c. Spontaneously verbalizes which was more before or says it changes

2. Expects constancy

+: a. Predicts that green cooky will have more to eat when a card conceals the illusion
b. First points to top cooky, then changes choice to bottom cooky so that it seems that choice of top at first resulted from failure to observe the illusion
c. Points to original bottom cooky as E moves a cooky
d. Verbalizes that he expects the size relationship to remain the same, e.g., "The bottom one cheats."
e. Surprise is at least moderate in response to the transformation
f. Maintains constancy, selecting top cooky while recognizing that bottom cooky appears larger

g. Insists upon putting the cooky chosen in the bottom position, e.g., "I want to pick it like this."

3. Believes the event is highly unusual, if not impossible

+: a. Surprise is intense in response to the transformation
b. Spontaneously suggests magical cause
c. Indicates disbelief in change; chooses top cooky while recognizing that bottom cooky appears larger
d. Indicates puzzlement, surprise, suspicion, doubt, e.g., "How do you do that?" "Do you know how it gets to be more to eat?" "It looks funny when you do that." "The bottom one cheats." "It shouldn't do that!" "That one's supposed to be bigger, but it's not." Also: accuses E of trick; spontaneous manipulation of cookies in doubt or disbelief; says doesn't know if it changed; marked hesitation in responding
e. Thinks he must have been mistaken in his first view of the cookies and says the bottom cooky had more when it was on top (Failure on memory question is not failure of memory but questioning of original judgment)

4. At least momentarily denies real change in either quantity of single cooky or in quantitative relationship between the two cookies

+: a. Says no to one "really change" question
b. Says no to one "more to eat" question
c. Says no to "really bigger" question
d. Says it stays the same or spontaneously offers other verbalization of belief in lack of change
e. Maintains constancy at some point: picks top cooky while recognizing that bottom cooky appears bigger
f. Thinks he must have been mistaken in first view of cookies and says the bottom cooky had more when it was on top

Note: Score - if a no response is qualified in such a way as to contradict, e.g., (Did it get bigger?) "No, the other one got smalled."

5. Attempts concrete explanation of apparent change

+: a. Verbalizes a logical reason for conservation
1) Logical compensation: If both are bigger, they're the same size, or both are big
2) It just looks like it gets/is bigger; it just does that
3) It was bigger before
4) It can't change; it stays the same; it's always biggest; it can't stretch
5) One is bent more; it's tilted/slanted
6) Difference in arc lengths
7) It's cut bigger; it's born that big
8) None was added or taken away
9) It's just imagination
10) It looks smaller when it's further away
11) It's an eye-fooler
12) Shape prevents direct comparison

b. Suggests E just put one further to the side which causes false effect

c.

d. Says something concrete causes the change, e.g., the board (but not magic), fuse box, camera, microphone

e. Accuses E of sneaking in another cooky or cutting it

f. Makes clumsy attempt at concrete explanation, e.g., "Maybe it takes more room," "The higher it is, the gets like shorter (really shorter) No." "You took some one and put it on the other."

g. Actively experiments, e.g., moves off board to see if change will occur elsewhere, superimposes or otherwise maniuplates experimentally

h. Does not need to seek concrete explanation as maintains constancy throughout

6. Maintains identity by the end of the interview: believes in the constancy in quantity of single cooky

+: A spontaneous verbalization outweighs answers to yes-no questions. A subject may agree to a real change in size or amount to eat, but then contradict or qualify so that it is clear that he believes the cooky does not actually increase or decrease. Examples of identity statements:

You got another cooky.
It doesn't really get bigger/longer/more to eat.
It doesn't really change from big to small when you move it (Q4).
They stay alike.
If you put it on top, it will still be bigger.
They don't change. It really is the same size.
It can't grow.

7. Maintains equivalency relationship by the end of the interview: believes in the constancy of the quantitative relationship between the two cookies

+: Says they are the same when in the illusion position after superimposition demonstrates equality, or maintains that one continues to be bigger when placed in top position although the other appears bigger.

8. Consistently conserves

+: Maintains constancy throughout the interview

9. Conserves with certainty

+: Never considers possibility that one cooky could have more in one position and not more in another position; does not vacillate in choices; does not remeasure.

Note that a response was considered unscorable if subject said the bottom cooky looked smaller or the top cooky looked bigger. If the bottom

cooky was selected and that choice was maintained when placed in upper position, the response was considered a conservation response.

In addition, verbalizations about the cause of the apparent transformation were classified as follows:

Nonconservation Reasons:

1. No reason or irrelevant reason given, e.g., "You move it," "You put it there," "I like that color," "That is curved bigger," "It's longer," "I measured it (but did not superimpose)," "They're made to be like that," "If you put this (upper cooky) here (in lower position), it's bigger, but if it's here (upper position), it's smaller."

2. Physical change is specified, e.g., "It's spread out," "It grew/shrank," "It takes more room when it's closer," "It gets smaller when it's further away."

3. Magic, e.g., "It's magic!"

4. Impossible or unreasonable concrete cause, e.g., "The board makes it happen (but not magic)," "You took some off one and put it on the other," "The camera (or other object in room) made it."

5. Arc difference, e.g., "It's longer here (top arc of lower cooky) than here (bottom arc of upper cooky)."

Conservation Reasons:

6. Vague reference to shape, e.g., "One is bent more," "It's tilted/slanted," "You can't get them together to check it because they're bent."

7. Identity, e.g., "It was bigger before," "It had the same amount before," "It can't change," "It stays the same," "It's always biggest," "It can't stretch," "The short stays short and the long stays long," "It's cut bigger," "It's born that big."

8. Addition-subtraction principle, e.g., "You didn't put any more cooky on it," "You didn't take any cooky away."

9. Illusion, e.g., "It just looks like it gets bigger," "It just does that," "Maybe it's just my imagination," "It makes your eyes think it's changing," "It's an eye-fooler," "The one that's closest looks bigger, and the one that's further away looks smaller."

10. Arc difference, e.g., "This looks bigger because this (top arc of lower cooky) is next to this (bottom arc of upper cooky)."

RESULTS

Developmental Sequence

The foregoing set of items can be said to describe an invariant

developmental sequence of acquisition, on the basis of the following, converging lines of evidence:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis using Green's (1956) summary statistics was performed which indicates that the nine dichotomous items form a Guttman scale (Table 77 shows reproducibilities and indices of consistency). Table 78 presents the ten perfect scale patterns possible and shows the frequency and median age of bright, average, and retarded Ss found for each scale type.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 79 indicates that mean level of performance increases significantly with age ($F=9.89$, $df=2.86$, $p < .0002$). Table 80 shows that younger Ss tend to score at lower scale levels while older Ss tend to score at upper scale levels. Table 81 shows that the percentage of Ss succeeding on each scale item increases with age.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 82 shows the scale scores of 19 Ss at two testings separated by one year. Three Ss performed at the same level both times, 13 Ss performed at a higher level after one year, and 3 Ss performed at a slightly lower level. The scale accounts for performance change for most Ss.

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis performed separately for each IQ group indicated that the order of difficulty of scale items does not vary for groups differing in IQ (See Table 77). Evidence cited in the foregoing section concerning developmental sequentiality applies equally to all IQ groups.

TABLE 77

RESULTS OF SCALOGRAM ANALYSIS[a] OF JASTROW MASS CONSERVATION ITEMS FOR BRIGHT, AVERAGE, AND RETARDED GROUPS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.99754	.98843	.98738
Chance Reproducibility	.97381	.92587	.84654
Index of Consistency	.90605	.84392	.91776

[a]Using Green's (1956) summary statistics

TABLE 78

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS SCORING AT TEN LEVELS ON THE JASTROW MASS CONSERVATION SCALE (N=137)

Scale Score	SCALE ITEMS									BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	7	8	9	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
9	+	+	+	+	+	+	+	+	+	20	-	85	1	-	79	2	-	109
8	+	+	+	+	+	+	+	+	-	2	0	87	1	0	93	0	0	-
7	+	+	+	+	+	+	+	-	-	5	0	77	3	0	80	4	0	107
6	+	+	+	+	+	+	-	-	-	6	1	71	5	1	94	0	0	-
5	+	+	+	+	+	-	-	-	-	6	0	76	13	1	74	11	0	110
4	+	+	+	+	-	-	-	-	-	0	0	-	4	0	70	5	2	109
3	+	+	+	-	-	-	-	-	-	3	0	71	10	2	68	4	2	120
2	+	+	-	-	-	-	-	-	-	2	0	64	5	1	79	12	0	90
1	+	-	-	-	-	-	-	-	-	0	0	-	1	0	93	1	1	95
0	-	-	-	-	-	-	-	-	-	0/44	0/1	-	0/43	-/5		0/39	-/5	-
n	131	134	112	96	84	52	40	27	23									
$\bar{n}$	6	3	25	41	53	85	97	110	114									

TABLE 79

MEAN JASTROW MASS CONSERVATION TEST SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.75	4.88	4.81	3.67	3.88	3.76	3.43	2.00	2.54
6	8.00	7.12	7.56	3.88	4.67	4.29	4.00	3.75	3.88
7	8.50	7.38	7.94	4.88	4.50	4.69	5.38	4.25	4.81
Mean All Ages	7.08	6.46	6.77	4.12	4.36	3.24	4.08	3.52	3.74

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 80

PERCENTAGE OF JASTROW MASS CONSERVATION SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]

Ability Group	Age	0	1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	00	13	13	13	00	12	31	06	00	12
	6 (N=16)	00	00	00	00	00	25	00	19	06	50
	7 (N=16)	00	00	00	06	00	00	13	13	06	62
Average	5 (N=17)	00	06	06	35	18	29	06	00	00	00
	6 (N=17)	00	00	29	12	06	35	00	12	00	06
	7 (N=16)	00	06	06	25	00	19	32	06	06	00
Retarded	5 (N=12)	00	00	75	00	09	08	00	08	00	00
	6 (N=16)	00	06	19	12	19	38	00	06	00	00
	7 (N=16)	00	06	00	25	19	25		13		12

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 81

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN SUCCEEDING ON EACH JASTROW MASS CONSERVATION SCALE ITEM AT THREE AGES[a] (N=142)

Ability Group		1	2	3	4	5	6	7	8	9
Bright	5 (N=16)	100	100[c]	75	62	62	46[b]	19[b]	12	12
	6 (N=16)	94	100	100	100	100	75	75	62	50
	7 (N=16)	100	100	100	94	94	94	81	69	62
Average	5 (N=17)	100	100[b]	94	53	35	06	00	00	00
	6 (N=17)	94	94	65	71	53	24	18	06	06
	7 (N=16)	88	94	88	69	62	44	19	06	00
Retarded	5 (N=12)	100	100	23	15	23	08	08	00	00
	6 (N=16)	94	94	69	69	50	06	06	00	00
	7 (N=16)	94	100	94	69	50	25	25	12	12

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

[b] N=15

[c] N=14

TABLE 82

DIRECTION OF CHANGE IN PERFORMANCE ON JASTROW MASS CONSERVATION TASK AFTER ONE YEAR: SCALE SCORES AT TWO TESTINGS (N=19)

Score at First Testing	Score at Second Testing									
	0	1	2	3	4	5	6	7	8	9
0						1				
1										
2			1			2				
3			1			2	1			
4						2				
5						1		2		1
6						1				1
7										
8										
9									1	1

It appears that the order of developmental change is the same, regardless of IQ.

Level of Performance

Table 79 shows that bright children perform at a higher level than average or retarded children ($F=40.39$, $df=1, 86$, $p < .0001$ for bright and average groups). However, average children do not differ significantly from retarded children of the same mental age. Mental age is a significant factor in the performance of average and retarded children ($F=4.37$, $df=2, 81$, $p < .02$).

Sex Differences

No statistically significant differences in the performance of girls and boys were found.

OBJECT CLASSIFICATION

METHOD

The method used to assess classification skill was developed by Kohlberg (1966), based on work by Goldstein and Sheerer (1941), Weigl (1941) and by Piaget (1959). Objects used were two Flagg doll families which were identical except for some color differences in hair and clothing, two spotted china dogs, a green plastic dog, and a somewhat larger family of dolls having clothing distinctly different from the Flagg families.

Procedure

The first part of the task focussed upon eliciting the child's spontaneous method of classification. E emptied the objects from a paper bag onto the desk where the child sat so that they formed a disorganized pile. Instructions were:

> See all these things? Go ahead and find out what kinds there are while I get my papers ready. (E pretended to be busy until S had explored all the objects.) Now, I'd like you to put them in order for me. Put the ones together that go together.

After the child finished sorting the dolls, E asked, "Why do these go together? Why did you put them together?" for each grouping. If most groupings were associative (membership in group not resulting from shared characteristics of objects), Ss were told to, "Put the ones that are the same together."

The second part of the sorting task was designed to explore whether the child could utilize a superordinate class and whether he could shift his bases for groupings. E removed the dogs and placed two sheets of paper before the child, one to his right and one to his left. E said:

> Now we're going to take all these doils and make two piles out of them. Let's take this boy doll and put it on this paper (puts one of Flagg boys on one sheet). Now, put all the other ones that go with the boy on this paper, and put the other ones that go together on this paper over here.

S was asked to explain why he put each group together.

Scoring

Each grouping was classified according to the following criteria:

1. Associational: Grouping includes a non-identical object but is not a collectivity or categorical grouping. It is based on interaction among members, complementarity of status or role, or spatial or temporal contiguity of members. Reason may involve action of objects with each other or relationship of liking between them.

2. Identity: Identical objects are grouped.

3. Collectivity: A mother, father, and at least one child are included.

4. Categorical: Objects of more than one subcategory are included, and one non-identical object is present.

Ss were scored as passing (+) or failing (-) each of the following items:

1. Makes some similarity groupings spontaneously or on request

   +: Not all groups formed are associative

2. Most groupings are not associative

   +: Less than 50% of the groups formed are not associative (not based on weighted percentage; count all groups formed, including "forced sorts.")

3. Includes all objects

   +: Spontaneously includes all 21 objects in groups (more than one group must be formed: a line of the 21 objects would not be scored as passing). A single object may form a "group" if the child makes some positive statement about it, e.g., "He goes by himself because there's no other one like him," "He's left over, so he can be the policeman," "These go together because they don't have any like them." A single object is considered excluded if no statement is made or if the child says he intends it not to be included, e.g., "I can't put him anywhere," "He doesn't go with anybody," "I don't need these."

4. Uses complementary classes

   +: Can construct a system of two complementary classes (including all human objects). Examples: males and females; children and

adults. Question 2 is specifically designed to elicit this ability, but it may spontaneously appear prior to this. A verbal statement of opposite or bipolar classes may also be taken as indicative of this ability, e.g., 'You mean put all the girls together and all the boys together?"

Note: Where babies are excluded from male-female dichotomy because of uncertainty about sex, credit is also given on this item; however, score "-" if subject merely says, "There's nowhere to put them."

5. Includes all members of a class in more than 50 percent of the spontaneous groupings

+: All objects are included which could be, on the basis of the child's reason for grouping; also, no inappropriate objects are included. Groupings of identical objects and groupings based on associative reason are considered to fail in including all members.

6. More than 50 percent of weighted groupings are true categorical concepts

+: Spontaneous groupings are given one point each, but groupings made in response to "Put the ones together that are the same" and "Make two piles out of all the dolls" are given only one-half point. Any group constructed a second time in response to a new instruction is scored only once.

7. Uses overall system of inclusion

+: Entire set of objects is grouped according to general criteria so that groups form a hierarchical system, e.g., age, sex, species criteria result in an overall system of subclasses.

8. Shifts from one system of classification in spontaneous groups to another in the forced sort

+: Set of objects can be viewed as grouped according to more than one set of criteria, e.g., age groups may be formed as well as sex groups. The shift is from one categorical grouping to another categorical grouping; changing from family groupings to age or sex groupings does not comprise a shift. Shifting may occur spontaneously or in response to request to compose two complementary classes. Verbalization of awareness of more than one possible categorical arrangement is also scored "+", whether or not the arrangement is actually made, e.g., "Do you mean boys and girls or children and grown-ups?"

Results

Developmental Sequence

Evidence for the developmental sequentiality of the foregoing set of items is as follows:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis using Green's (1956) summary statistics was performed which indicates that the eight dichotomous items form a Guttman scale (Table 83 shows reproducibilities and indices of consistency). Table 84 presents the nine perfect scale patterns possible and shows the frequency and median age of bright, average, and retarded Ss found for each scale type.

2. Increasing success on scale items does not occur with increasing age. This finding attenuates the conclusion that the scale describes an invariant developmental sequence. Table 85 shows that only for average boys is there an increase in scale score with age. Generally, there is very little difference in scale scores of the various age groups. The analysis of variance indicated that the age effect is not a significant factor in performance for these age groups. Tables 86 and 87 which show percentage of scale scores and percentage succeeding on each scale item also reflect a general lack of age influence on performance.

3. Retesting of a small number of Ss after one year shows a general progression along the scale. Table 88 shows the scale scores of 19 Ss at two testings separated by one year. Of these, 2 Ss performed at the same level both times, 11 Ss performed at a higher level after one year, and 6 Ss scored at a lower level after a year. The scale does not account as satisfactorily as one would like for performance changes.

Effect of Intelligence of Performance Sequential Order of Acquisition

The scalogram analysis performed separately for each IQ group indicated that the order of difficulty of scale items holds for average and retarded groups, but that the set of items does not quite achieve scalability for the bright group. The rather large number of non-scale types (see Table 84)

TABLE 83

RESULTS OF SCALOGRAM ANALYSIS OF OBJECT SORTING ITEMS FOR BRIGHT, AVERAGE, AND RETARDED GROUPS (N=142)

Ratios Computed	Bright	Average	Retarded
Reproducibility	.95573	.96996	.97223
Chance Reproducibility	.91797	.89089	.91450
Index of Consistency	.46031	.72468	.67520

TABLE 84

MEAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS SCORING AT NINE LEVELS ON THE OBJECT SORTING SCALE
(N=142)

Scale Score	SCALE ITEMS								BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	7	8	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
8	+	+	+	+	+	+	+	+	1	-	77	2	-	94	1	-	140
7	+	+	+	+	+	+	+	-	6	0	74	13	0	74	4	0	95
6	+	+	+	+	+	+	-	-	5	1	75	1	1	69	1	0	117
5	+	+	+	+	+	-	-	-	3	2	88	2	1	90	5	0	109
4	+	+	+	+	-	-	-	-	12	1	77	9	3	77	12	3	98
3	+	+	+	-	-	-	-	-	8	6	77	5	5	68	7	5	96
2	+	+	-	-	-	-	-	-	3	0	68	2	2	84	1	2	100
1	+	-	-	-	-	-	-	-	0	0	-	1	0	82	1	0	118
0	-	-	-	-	-	-	-	-	0	-	-	2	-	63	1	-	110
n									38	10		37	12		33	10	
$\bar{n}$																	

TABLE 85

MEAN OBJECT SORTING SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=142)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.38	4.50	3.44	3.75	4.88	4.31	3.25	4.00	3.54
6	5.25	4.38	4.81	4.00	5.00	4.53	4.50	4.25	4.38
7	3.88	3.88	3.88	5.00	4.12	4.56	3.87	4.12	4.00
Mean All Ages	4.50	4.25	4.38	4.25	4.68	4.47	3.88	4.14	3.98

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 86

PERCENTAGE OF OBJECT SORTING SCALE SCORES OBTAINED BY BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] (N=142)

Ability Group	Age	Scale Score 0	1	2	3	4	5	6	7	8
Bright	5 (N=16)	00	00	13	19	31	06	12	19	00
	6 (N=16)	00	00	00	25	32	06	19	12	06
	7 (N=16)	00	00	06	44	19	19	06	06	00
Average	5 (N=16)	12	00	00	25	25	00	06	31	00
	6 (N=17)	00	06	06	29	18	06	00	35	00
	7 (N=16)	00	00	19	06	32	13	12	12	06
Retarded	5 (N=13)	00	08	15	23	38	08	00	08	00
	6 (N=16)	06	00	00	31	19	25	00	19	00
	7 (N=16)	00	00	06	32	44	06	06	00	06

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 87

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN SUCCEEDING ON EACH OBJECT SORTING SCALE ITEM AT THREE AGES[a]
(N=

Ability Group	Age	Scale Item 1	2	3	4	5	6	7	8
Bright	5 (N=16)	100	100	81	75	38	31	25	00
	6 (N=16)	100	100	94	81	31	38	19	19
	7 (N=16)	100	100	75	69	31	12	06	06
Average	5 (N=16)	88	88	75	62	50	38	31	00
	6 (N=17)	100	94	71	65	47	41	35	00
	7 (N=16)	100	88	88	69	50	31	25	06
Retarded	5 (N=13)	100	84	76	61	15	08	08	00
	6 (N=16)	94	94	88	56	50	25	19	00
	7 (N=16)	100	81	88	75	31	12	06	06

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 88

DIRECTION OF CHANGE IN PERFORMANCE ON OBJECT SORTING TASK
AFTER ONE YEAR: SCALE SCORES AT TWO TESTINGS
(N=19)

Score at First Testing	Score at Second Testing								
	0	1	2	3	4	5	6	7	8
0					1				
1				1					
2							1		
3			1	1	4				
4					1			3	
5								1	
6				1					
7			1		2		1		
8									

for all IQ groups also raises questions about the scale as a description of sequence of acquisition of classification ability.

Level of Performance

No statistically significant differences were found in the performance of the three IQ groups as reflected by scale scores.

Sex Differences

No statistically significant differences were found in the performance of boys and girls on this object sorting task.

TRANSITIVITY OF LENGTH RELATIONS

METHOD

The method of assessing ability to use transitive inference is based on the work of Piaget, Inhelder and Szeminska (1960). Materials used were twelve colored straws of gum and four wooden dowels $\frac{1}{4}$-inch in diameter, in the following lengths and colors:

Gum sticks

2 inches: two purple, four pink, two green
3-15/16 inches: one green and one yellow
3-13/16 inches: one yellow and one purple
3-1/4 inches: one purple
3-3/4 inches: one yellow

Wooden dowels (one each)

1-7/8 inches
2-1/8 inches
3-1/8 inches
3-7/8 inches

Position and color of correct gum were varied so that position or color preference would not result in false positives.

Procedure

Two small wooden stands (desk-height, with tops about 6 inches square) were placed at either side of the desk at which S was seated. E sat across from S with the wooden dowels concealed in a cardboard box under the clipboard on which she recorded the interview.

The first item was designed to assess the child's spontaneous use of measurement in order to arrive at a transitive inference. E placed a short yellow (3-13/16") gum stick on the stand to S's left and a long green (3-15/16") gum stick on the stand to S's right, saying:

> Now, when I say so, I want you to find out which of these two pieces of gum is bigger, which has more gum to chew. If you can pick the bigger one, I'll give it to you to keep. If you don't pick the bigger one, you won't get gum this time, but you'll have another chance to get gum later. You have to tell which one is bigger without moving the pieces of gum away from the tables, but you can use this wooden stick any way you want.

You can move it to the tables if you want to. Go ahead. Find out which is bigger. Point to the bigger one that has more gum to chew.

E gave S the 3-7/8" dowel and noted whether he measured spontaneously or not. E asked:

How do you know it's bigger?

(If did not measure): What if I thought this (gum child did not choose) is the bigger one, how could you show me it's not?

(If S still did not measure): Can you measure with the stick and make sure?

All Ss were allowed to take the gum selected.

Item 2 was used to demonstrate measuring, to insure the opportunity for S to note the size of gum sticks relative to a measuring rod, and to find whether S could use transitive inference when these facts were presented. E dropped the dowel used in Item 1 back in the box in her lap and placed a purple gum stick (2") on the stand to S's left and a pink gum stick (2") on the stand to S's right, saying:

Here, now I'll take a stick (1-7/8" dowel). I'll want you to show me the bigger piece of gum when I say so. If you pick the bigger piece, you can keep it. If you don't pick the biggest one with more gum to chew, you won't get gum this time, but you'll have another chance later. Watch me first.

(E stood pink gum and stick side by side on the stand.) Which is bigger? Point to the bigger one. Yes, the gum is bigger.

(E dropped the dowel back in the box and wrote on the protocol a moment. Then E took 2-1/8" dowel and stood it beside the green gum on the stand.) Which is bigger? Point to the bigger one. Yes, the stick is bigger.

Now (pointing simultaneously to the two gum sticks), which gum is bigger? You point to the bigger piece of gum with more to chew. How do you know it's bigger?

If S was correct on both Items 1 and 2, E moved to Item 6. If S did not use transitive inference on Item 1 but made the transitive pink choice on Item 2, he was allowed to take the gum, and E moved to Item 5. If S made the non-transitive purple choice, he was not allowed to take the gum,

and E moved to Item 3.

Item 3 was designed to assess whether S remembered the size relations of the gum sticks with the dowels, to provide a review of these if S had forgotten, and to find whether this help would result in change to a correct response. E asked:

> Which is bigger, the purple gum or the stick (pointing to purple gum)? Which is bigger, the pink gum or the stick (pointing to pink gum)?
>
> (If S was incorrect on either question): No, see (E measured with dowel, as in Item 2), the stick/gum is bigger.
>
> Which is bigger, the pink or purple gum (pointing to both simultaneously)? Point to the bigger one. How do you know it's bigger?

Item 4 was a repeat of Item 2, to find whether the assistance provided in Item 3 would result in use of transitive inference in a new situation since a correct response to Item 3 might have occurred if S did not use transitive inference but viewed E's help as an instruction to merely change his choice. E placed a pink gum stick (2") on the stand to S's left and a green (2") gum stick on the stand to S's right, repeating the procedures as in Item 2 (measuring green gum with 1-7/8" dowel and pink with 2-1/8" dowel). S was permitted to take the gum he selected, and Item 5 was administered next.

Item 5 was a repeat of Item 1, to assess whether S had learned how to measure and whether he could use the middle term to arrive at a transitive inference after the helping items. E placed a long yellow gum stick (3-15/16") on the stand to S's left and a short purple gum stick (3-13/16") on the stand to S's right. Instructions were identical to those in Item 1. S was allowed to take the gum stick he chose. If S selected the short green gum, E terminated the test. If the long yellow gum was selected, Items 6 and 7 were administered.

Item 6 was designed to explore the S's possible reliance on the

single comparison of bigger gum to shorter stick without reference to the comparison of shorter gum to longer stick. Also, it provided an opportunity to assess S's view of the measurement of both gum sticks as a logical necessity. E placed a green gum (2") on the stand to S's left and a pink gum (2") on the stand to S's right, saying:

> When I say so, I want you to tell me which of these is bigger, which has more gum to chew. If you pick the bigger one, you can have it to keep. If you don't pick the bigger one, you won't get gum this time. Watch me first. (E measured the green gum with the shorter 1-7/8" dowel.) Now, which gum is bigger (pointing to both)? Show me the bigger one. How do you know it's bigger?

E permitted the child to take the gum he selected and then placed a purple gum (2") on the stand to S's left and a pink (2") on the stand to S's right. The same instructions were given, and E measured the purple gum with a longer (2-1/8") dowel.

Item 7 was designed to assess the use of transitive inference in a situation where it contradicts a strong perceptual cue. E placed a shorter purple gum stick (3-1/4") on the stand to S's left and a longer yellow gum stick (3-3/4") on the stand to S's right, saying:

> Now when I say so, I want you to tell me which of these is bigger, which has more gum to chew. If you pick the bigger one, you can have it to keep. If you don't pick the bigger one, you won't get gum this time. Look at both of them. Now watch me. (E measured purple gum with shorter dowel (3-1/8"). Which is bigger? Yes, the gum is bigger. (E replaced dowel in box and wrote momentarily on the protocal, then took longer dowel (3-7/8") and measured yellow gum.) Which is bigger? Yes, the stick is bigger. Now (pointing to both gum sticks), which is bigger? You point to the bigger piece of gum with more to chew. How do you know it's bigger?

If the child chose the yellow gum, E ascertained whether he had forgotten the outcome of the measuring operation:

> Which is bigger, the stick or the purple gum?
> Which is bigger, the stick or the yellow gum?

If S gave incorrect responses, E again demonstrated the measuring and then instructed S to take the bigger one. If the choice was changed, E asked, "Why did you change your mind?". If the child selected the shorter purple

gum, E ascertained whether the perceptual disparity was noticed by saying, "Yes. Which one looks bigger?" The child was allowed to take the gum selected.

Length Transitivity Scoring

1. Shows some use of transitive inference prior to help

   +: Chooses longer on Q2
   Spontaneously measures and chooses longer on Q1 (Note: "Spontaneously" is defined as comparison of both gums with the stick before E says, "Can you measure?")

2. Does not rely solely on single comparison of stick with longer gum

   +: Correct on Q6 when the longer stick is measured against a shorter gum stick
   Wants to measure both gum sticks on Q6
   Incorrect selection occurs, but subject indicates that he can't really know for sure when only one gum is measured, e.g., "You only measured that one."

3. At least makes transitive inference after help

   +: Measures and picks longer on Q1 and picks gum measured with shorter stick on Q2
   Measures and picks longer on Q5 and picks gum measured with shorter stick on Q2
   Measures and picks longer on Q5 and picks gum measured with shorter stick on Q4

4. Makes use of transitive inference where there is no perceptual contradiction

   +: Measures and picks longer gum on Q1 and picks gum measured with shorter stick on Q2

5. Uses transitive inference in the face of strong perceptual contradiction

   +: On Q7, takes the shorter gum, but says the other looks bigger
   On Q7, takes the shorter gum, but points to the longer one before the misleading measuring operation is performed

6. Consistently uses transitive inference throughout test

   +: At no time selects intransitive gum stick or vacillates with uncertainty

Note: Spontaneous measuring is not required for success on Items 3 and 4, as long as both gum sticks are compared with the stick at some point before the item is finished.

RESULTS

Developmental Sequence

The foregoing set of items seem to describe an invariant developmental sequence of acquisition, on the basis of the following lines of evidence:

1. The items are ordered in terms of increasing difficulty. A scalogram analysis using Green's (1956) summary statistics was performed which indicates that the six dichotomous items presented above form a Guttman scale (Table 89 shows reproducibilities and indices of consistency). Table 90 presents the seven perfect scale patterns possible and indicates the number of Ss in each ability group found for each scale type.

2. Increasing success on scale items occurs with increasing age and reflects the order of difficulty. Table 91 indicates that mean performance tends to increase with age for bright and average children, although mean performance for bright seven-year-olds drops somewhat behind that of bright six-year-olds. The analysis of variance showed the age effect to be significant ($F=3.17$, $df=2, 84$, $p < .05$ for bright and average groups). Table 92 shows that the lower scores tend to be made by younger children and the higher scores by older children, with the exception noted above regarding bright six- and seven-year-olds. These age trends are also reflected in Table 93 which shows that the percentage of subjects succeeding on each scale item increases with age, except for the older bright group.

3. Retesting of Ss after one year shows a general progression along the scale. Table 94 indicates that of the 18 retested Ss, 17 either performed at the same or higher levels, and that only 1 S scored at a lower level at the second testing. Thus, the scale accounts quite well for the performance changes in most Ss.

TABLE 89

RESULTS OF SCALOGRAM ANALYSIS OF LENGTH TRANSITIVITY ITEMS FOR BRIGHT, AVERAGE, AND RETARDED GROUPS

Ratios Computed	Bright	Average	Retarded
Reproducibility	.99048	.94584	.95727
Chance Reproducibility	.93836	.88436	.89106
Index of Consistency	.84555	.53164	.60765

TABLE 90

MEDIAN AGE AND FREQUENCY OF BRIGHT, AVERAGE, AND RETARDED SUBJECTS
AT EACH LENGTH TRANSITIVITY SCALE LEVEL
(N=114)

Scale Type	SCALE ITEMS						BRIGHT			AVERAGE			RETARDED		
	1	2	3	4	5	6	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type	Scale Type	Non Scale Type	Med. Age Scale Type
6	+	+	+	+	+	+	17	-	80	12	-	80	11	-	110
5	+	+	+	+	+	-	3	0	77	2	0	94	2	1	106
4	+	+	+	+	-	-	9	2	88	10	0	88	5	5	109
3	+	+	+	-	-	-	3	0	87	4	4	81	5	2	116
2	+	+	-	-	-	-	0	0	-	3	2	84	3	2	93
1	+	-	-	-	-	-	0	0	-	1	2	67	3	0	98
0	-	-	-	-	-	-	1/33	-/2	69	0/32	-/8	-	0/29	-/10	-
n	107	103	98	73	61	41									
n	7	11	16	41	53	73									

TABLE 91

MEAN LENGTH TRANSITIVITY SCALE SCORES FOR BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a]
(N=141)

AGE	BRIGHT			AVERAGE			RETARDED		
	Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	4.00	4.50	4.25	2.62	3.88	3.25	3.38	2.40	3.00
6	5.50	5.00	5.25	3.43	4.22	3.87	4.12	4.75	4.44
7	4.88	4.50	4.69	4.62	4.37	4.50	4.38	3.50	3.94
Mean All Ages	4.79	4.67	4.73	3.56	4.16	3.87	3.96	3.71	3.84

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 92

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN AT THREE AGES[a] SCORING AT SEVEN LENGTH TRANSITIVITY SCALE LEVELS (N=141)

Ability Group	Age	0	1	2	3	4	5	6
Bright	5 (N=16)	06	13	00	06	13	31	31
	6 (N=16)	00	00	00	06	25	06	63
	7 (N=16)	00	00	00	12	44	06	38
Average	5 (N=16)	00	19	25	19	12	00	25
	6 (N=16)	00	00	12	45	12	06	25
	7 (N=16)	00	00	06	12	38	12	31
Retarded	5 (N=13)	08	15	15	23	31	08	00
	6 (N=16)	00	06	12	00	31	12	39
	7 (N=16)	00	12	06	25	19	06	32

[a]Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 93

PERCENTAGE OF BRIGHT, AVERAGE, AND RETARDED CHILDREN SUCCEEDING ON EACH LENGTH TRANSITIVITY SCALE ITEM AT THREE AGES[a] (N=141)

Ability Group	Age	1	2	3	4	5	6
Bright	5 (N=16)	94	82	82	75	59	31
	6 (N=16)	100	100	100	88	75	59
	7 (N=16)	100	100	100	82	50	38
Average	5 (N=16)	75	88	56	38	44	25
	6 (N=16)	94	88	88	50	44	25
	7 (N=16)	100	94	94	82	50	31
Retarded	5 (N=13)	84	76	76	13	30	08
	6 (N=16)	100	88	88	69	62	38
	7 (N=16)	94	82	82	62	44	31

[a] Bright and average Ss are grouped according to chronological age, and retarded Ss are grouped according to mental age.

TABLE 94

FREQUENCY AND DIRECTION OF CHANGE IN LENGTH TRANSITIVITY SCALE SCORE AMONG SUBJECTS RETESTED AFTER ONE YEAR (N=18)

Score at First Testing	Score at Second Testing						
	0	1	2	3	4	5	6
0					1		
1				1	1		1
2			1		1		
3				1	4		1
4					1		
5							1
6					1		3

Effect of Intelligence on Performance

Sequential Order of Acquisition

The scalogram analysis performed separately for each IQ group indicated that the order of difficulty of scale items does not vary for groups differing in IQ (see Table 89).

Level of Performance

Bright children's performance is better than than that of average and retarded children (see Table 91). The analysis of variance indicated this difference is statistically significant ($F=7.72$, $df=1, 84$, $p < .0007$ for bright and average groups). However, the difference in performance of average children and retardates of the same mental age is not significant. Mental age appears to be a more potent factor than IQ in acquisition of transitive inference.

Sex Differences

No significant sex differences appeared, but once again the pattern of girls being somewhat superior at lower ages and inferior at age seven appears.

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RELATIONS AMONG PIAGET, PSYCHOMETRIC, ACHIEVEMENT, AND INKBLOT ASSESSMENTS

A previous factor-analytic (Kohlberg and DeVries, 1969) supported the notion that Piagetian assessments tap something quite general and distinct from hereditary general intelligence. That factor analysis of performance on a battery of psychometric tests and Piaget tests defined a first psychometric factor, a second Piaget conservation factor, and a third Piaget classification factor. The present study was designed to explore the relationship of Piagetian assessments to standardized achievement measures and to measures of performance on a projective inkblot task. Tables 95-103 present the factors and loadings of various groupings of these measures. Analyses were made of 1) Piaget tests and Stanford-Binet MA (Table 95), 2) Piaget tests and Stanford-Binet IQ (Table 96), 3) Piaget tests, California Test of Mental Maturity (CTMM), and Stanford-Binet MA (Table 97), 4) Piaget tests, CTMM, and Stanford-Binet IQ (Table 98), 5) Metropolitan Test of Achievement (MAT), and Stanford-Binet MA (Table 99), 6) Piaget tests, MAT, and Stanford-Binet IQ (Table 100), 7) Piaget tests and Thorpe's HIT Developmental Variables (Table 101), 8) Piaget tests, Developmental Variables, and CTMM (Table 102), and 9) Piaget tests, Developmental Variables, and MAT (Table 103). Since some Ss (83 Ss) had been given the California Test and some the Metropolitan (56 Ss), and since no retardates had been given any achievement tests, these analyses together provide the composite for study.

It is clear that the mental age measure is more closely associated with Piagetian measures than IQ, and that measures of achievement are related only to the more difficult Piagetian tasks. The CTMM factor includes S-B MA, Class Inclusion, Left-Right Perspective, Magic Concepts and Dream Concepts, but the MAT factor includes no Piagetian tasks except for a low loading of Sibling Egocentrism. It is interesting that the MAT

Arithmetic measure loads on a different factor than Number Conservation. In summary, the findings indicate that achievement tests and Piaget tests are tapping generally different aspects of cognitive functioning.

Tables 101-103 present the results of factor analyses of Piaget assessments, achievement measures, and assessments of inkblot projections derived by Thorpe (1960) from Holtzman's (1961) scoring variables. Contrary to expectation, Thorpe's developmental indices are not generally associated either with Piagetian measures or achievement measures. The MAT, particularly, is defined by a factor separate from both Piagetian and inkblot measures. In summary, it appears that measures of inkblot performance also tap an aspect of functioning separate from both Piagetian and achievement measures.

TABLE 95

Factor Loadings: Product Moment Correlations of Piaget Tests and Mental Age (N=134)

Factor	Factor Loading	Task
1	.81	Number Conservation
	.81	Liquid Conservation
	.77	Length Conservation
	.75	Mass Conservation
	.72	Ring Illusion Conservation
	.54	Generic Identity Constancy
	.53	Sex-Role Constancy
	.31	Sibling Egocentrism
2	.72	Mental Age (Stanford-Binet)
	.67	Left-Right Perspective
	.63	Class Inclusion
	.59	Length Transitivity
	.59	Guessing Game
	.48	Magic Concepts
	.21	Object Classification

TABLE 96

Factor Loadings: Product Moment Correlations of Piaget Tasks and Stanford-Binet IQ (N=134)

Factor	Factor Loading	Task
1	.83	Number Conservation
	.81	Liquid Conservation
	.81	Mass Conservation
	.72	Length Conservation
	.61	Ring Illusion Conservation
2	.76	Left-Right Perspective
	.68	Class Inclusion
	.54	Length Transitivity
	.45	Magic Concepts
3	-.87	Generic Identity Constancy
	-.87	Sex-Role Constancy
4	.80	Object Classification
	.50	Guessing Game
	.46	Stanford-Binet IQ
	.36	Sibling Egocentrism

TABLE 97

Factor Loadings: Product Moment Correlations of Piaget Tasks, California Test of Achievement, and Stanford-Binet Mental Age (N=83)

Factor	Factor Loading	Task
1	.85	Number Conservation
	.81	Liquid Conservation
	.79	Mass Conservation
	.74	Length Conservation
	.60	Ring Illusion Conservation
2	.75	Mental Age
	.74	California Language
	.73	California Non-Language
	.66	Class Inclusion
	.63	Left-Right Perspective
	.59	Magic Concepts
3	.74	Length Transitivity
	.66	Guessing Game
4	.87	Generic Identity Constancy
	.87	Sex-Role Constancy
5	.75	Sibling Egocentrism
	.63	Object Classification

TABLE 98

Factor Loadings: Product Moment Correlations of Piaget Tasks, California Test of Achievement, and Stanford-Binet IQ (N=83)

Factor	Factor Loading	Task
1	.84	Number Conservation
	.80	Liquid Conservation
	.79	Mass Conservation
	.73	Length Conservation
	.60	Ring Illusion Conservation
2	.75	California Language
	.71	California Non-Language
	.67	Class Inclusion
	.67	Left-Right Perspective
	.57	Magic Concepts
	.42	Dream Concepts
3	.67	Guessing Game
	.62	Length Transitivity
	.61	Object Classification
	.59	Stanford-Binet IQ
4	.88	Generic Identity Constancy
	.86	Sex-Role Constancy
	.28	Sibling Egocentrism

TABLE 99

Factor Loadings: Product Moment Correlations of Piaget Tasks, Metropolitan Test of Achievement, and Stanford-Binet Mental Age (N=56)

Factor	Factor Loading	Task
1	.84	Number Conservation
	.82	Liquid Conservation
	.80	Mass Conservation
	.73	Length Conservation
	.60	Ring Illusion Conservation
2	.72	Mental Age
	.69	Left-Right Perspective
	.64	Guessing Game
	.63	Class Inclusion
	.58	Length Transitivity
	.53	Dream Concepts
	.46	Magic Concepts
	.18	Object Classification
3	.68	Metropolitan Word Discrimination
	.67	Metropolitan Word Knowledge
	.63	Metropolitan Reading
	.55	Metropolitan Arithmetic
	.31	Sibling Egocentrism
4	-.87	Sex-Role Constancy
	-.86	Generic Identity Constancy

TABLE 100

Factor Loadings: Product Moment Correlations of Piaget Tasks, Metropolitan Test of Achievement, and Stanford-Binet IQ (N=56)

Factor	Factor Loading	Task
1	.84	Number Conservation
	.81	Liquid Conservation
	.80	Mass Conservation
	.73	Length Conservation
	.62	Ring Illusion Conservation
2	.68	Metropolitan Word Discrimination
	.67	Metropolitan Word Knowledge
	.64	Metropolitan Reading
	.55	Metropolitan Arithmetic
3	-.76	Object Classification
	-.58	Guessing Game
	-.51	Stanford-Binet IQ
	-.49	Length Transitivity
	-.29	Sibling Egocentrism
4	-.87	Sex-Role Constancy
	-.87	Generic Identity Constancy
5	-.74	Left-Right Perspective
	-.68	Class Inclusion
	-.52	Dream Concepts
	-.47	Magic Concepts

TABLE 101

Factor Loadings: Product Moment Correlations of Piaget Tasks and Holtzman Developmental Variables (N=134)

Factor	Factor Loading	Task of HIT Variable
1	.77	Number Conservation
	.76	Length Conservation
	.74	Liquid Conservation
	.68	Ring Illusion Conservation
	.68	Mass Conservation
	.58	Generic Identity Constancy
	.57	Sex-Role Constancy
	.51	Dream Concepts
	.46	Magic Concepts
	-.33	Fi (active)
	-.25	D+
	-.19	Wi
2	.84	dm
	.74	dv
	.66	d+
	.57	FX_2
	.54	da^2
	.46	Dm
	.36	d++
	.35	Wv
3	.74	Wm
	.65	FX_1
	.57	HM^1 (active)
	.38	W++
	-.38	Da
	.35	Sibling Egocentrism
	-.31	Dv
	.27	W+
	-.15	d-
4	.64	XF
	.57	D++
	.49	Wa
	.41	Di
	.32	Object Classification
	-.21	W-
5	.61	Guessing Game
	.60	Length Transitivity
	.56	Left-Right Perspective
	.47	Class Inclusion
	.22	X

TABLE 102

Factor Loadings: Product Moment Correlations of Piaget Tasks, Holtzman Developmental Variables, and California Test of Achievement (N=83)

Factor	Factor Loading	Task of HIT Variable
1	.67	California Non-Language
	.67	California Language
	.66	Class Inclusion
	.63	Magic Concepts
	.57	Left-Right Perspective
	.57	Dream Concepts
	.45	Generic Identity Constancy
	.44	Sex-Role Constancy
	.42	Guessing Game
	.38	Wv
	.37	Length Transitivity
	.25	W+
2	.83	dm
	.81	dv
	.69	d+
	.66	da
	.32	Dm
	.30	d++
	-.19	W-
3	.76	FX_1
	.54	HM^1 (active)
	.51	D++
	.50	Wm
	.46	W++
	.39	Di
	.36	Sibling Egocentrism
	-.32	Da
4	.64	XF
	.55	Wa
	-.46	FX_2
	.42	Object Classification
	.27	Dv
	-.26	D+
	.12	d-
5	-.83	Number Conservation
	-.76	Liquid Conservation
	-.70	Length Conservation
	-.69	Mass Conservation
	-.62	Ring Illusion Conservation
	-.21	X
	.18	Fi (active)
	.15	Wi

TABLE 103

Factor Loadings: Product Moment Correlations of Piaget Tasks, Holtzman Developmental Variables, and Metropolitan Test of Achievement (N=56)

Factor	Factor Loading	Task or HIT Variable
1	.82	Number Conservation
	.79	Ring Illusion Conservation
	.76	Liquid Conservation
	.69	Length Conservation
	.59	Mass Conservation
	.58	Dream Concepts
	.53	Magic Concepts
	.52	Guessing Game
	.48	Class Inclusion
	.46	Sex-Role Constancy
	.44	Generic Identity Constancy
	.41	Left-Right Perspective
	.37	Length Transitivity
	-.15	Fi (active)
	-.14	Wi
2	.83	dm
	.81	dv
	.64	d+
	.63	da
	-.39	Wv
	.37	Dm
	.33	d++
3	-.73	FX_1
	-.54	HM^1 (active)
	-.52	Wm
	-.52	D++
	-.47	W++
	-.40	Di
	-.36	Sibling Egocentrism
	.35	Da
	.16	W-
4	.56	Metropolitan Word Knowledge
	.55	Metropolitan Word Discrimination
	.52	Metropolitan Reading
	.50	Metropolitan Arithmetic
	-.28	X
	-.21	d-
5	.65	XF
	.57	Wa
	-.47	FX_2
	.43	Object Classification
	.26	Dv
	-.25	D+
	-.23	W+

EDUCATIONAL IMPLICATIONS

The implications of this study for education center upon what is usually considered the definitive objective of public education: the intellectual growth of the child. These concern the nature of intelligence, its course of growth, its assessment, and its development in children more and less relatively well-endowed.

Individual intellectual power has been traditionally assessed with psychometric intelligence tests, and intellectual growth has been assessed with standardized achievement tests. The findings of this study, taken together with those of a previous study (Kohlberg and DeVries, 1969), suggest that these measurement techniques provide limited measures of cognitive functioning. The fact that Piagetian assessments measure aspects of the intellect different from what is measured by either intelligence tests or achievement tests suggests that they and other such measures should be seriously considered for use in assessing cognitive growth. It is suggested that the Piagetian methods actually provide a clearer assessment of reasoning process and the quality of thought than the standardized measures which tend to provide an assessment of thought product. Achievement tests, psychometric tests, and Piaget-type tests are all probably important and desirable assessments, but it is necessary to be clear about what each measures and how each is limited in its assessment. The development of reasoning abilities, usually cited as a, if not the, high-priority objective of schooling, are more appropriately assessed by Piaget-type methods.

It is significant that even though the CTMM subtests were supposed to measure different intellectual skills, these subtests loaded on the same factor and were highly correlated. The CTMM Language Subtest correlated .49 with the Non-Language Subtest. The MAT Subtests together defined a

separate factor, but their intercorrelations were not high (ranging .17 to .30). Thus, these achievement subtests appear to be measuring areas of functioning more similar than dissimilar when placed in the context of Piagetian task functioning. In this regard, it is also interesting to note that the MAT Arithmetic test loads on a different factor than does Number Conservation, and that these two tasks correlate only .07. Thus, it appears that the arithmetic achievement test fails to measure a most basic aspect of number knowledge which is necessary for elementary arithmetic tasks.

The study clearly indicates that the sequence of acquisition of the skills assessed by these Piaget-type tasks is the same for children differing in psychometrically-defined intelligence. This suggests that curricula designed to facilitate developmental progression in these areas might not need to be generally different for groups differing in IQ.

It is significant that psychometric mental age is a better predictor of performance in Piagetian tasks than IQ. Even bright children 5-7 years of age exhibit preoperational thought on the Piagetian tasks. At age 5, bright children appear to be more like average children on most of the tasks. However, bright children move through the stage sequence faster than average children, and they are in general superior to average children in their reasoning. Nonetheless, even bright children at age 7 have not generally completed the transition to concrete operational thought. It is a mistake, therefore, for educators to assume the young bright child's reasoning is as mature as his vocabulary and language development might suggest. Similarly, the reasoning of retardates mentally aged 5-7 years is little different from that of average children comparable in mental age. However, on two tasks, retardates are superior to average

children (Constancy of Generic Identity and Sex-Role Identity), and on five other tasks (Liquid, Length, Magic, and Dream) they are superior at mental age 7 years. This may suggest that the greater general experience of the retardates has contributed to their advance in some areas of reasoning. Thus, it is a mistake for special educators of young retarded children to assume that their reasoning is quite as immature as their vocabulary and language development might suggest. It should be cautioned, however, that this picture might be and probably is, very different when one considers children of higher mental age. There is likely a point beyond which retardates do not go, and this point may be prior to the level of formal operations on some reasoning process abilities.

In summary, the study of cognitive development with Piaget-type tasks points out some limitations of traditional achievement tests in assessing intellectual competence and indicates that Piaget-type tests provide an assessment of a different and important dimension to intellectual functioning.

Footnotes

[1]Since the goal here is diagnostic rather than educational, the child's spontaneous way of thinking is reinforced.

[2]Q12-13 were added to the procedure midway in the testing as a result of a spontaneous comment by a bright six-year-old. He correctly identified E's right and left hands as she faced him and said, "Ha, ha, you know how I know? My college sister told me it's always opposite for the other person!" This suggested the possibility that he might be answering the Q correctly without really understanding the relativity. In order to explore this, E turned her back to him, asked him to identify her hands, and discovered that he then incorrectly labelled them as a result of applying his verbal rule. Therefore, only 79 Ss were scorable on all scale items, and the scaling results reported are based on these Ss.

[3]These non-scale types are patterns of scores different from the perfect patterns shown. The individual's scale score is simply the number of items passed.

[4]Scale Item 1 is probably improperly included as part of the developmental sequence. However, it contributed little error (only 3 Ss with non-random patterns failed Item 1).

[5]Recipe: Mix together 1/3 cup margarine, 1/3 cup white syrup, 1/2 teaspoon salt, 1 teaspoon vanilla, and 3-1/2 cups powdered sugar. Add red food coloring to make bright pink candy.

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